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Vol. XXVI.]
No. 644.]

MARCH 28, 1890.

[PRICE
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THE
TELEGRAPHIC JOURNAL
ELECTRICAL REVIEW

LONDON: PUBLISHING OFFICE, 22, PATERNOSTER ROW, E.C.—Subscription per annum, Postage inclusive, in Great Britain, 19s. 6d.; to Countries in Postal Union, of the first class, 21s. 8d.; of the second class (Aden, India, Persia, &c.), 23s. 10d.—New York: D. Van Nostrand, 23, Murray Street, and 27, Warren Street. Paris: Madame Veuve J. Boyveau, Librairie Etrangère, 22, Rue de la Banque. Berlin: A. Asher & Co., 5, Unter den Linden.

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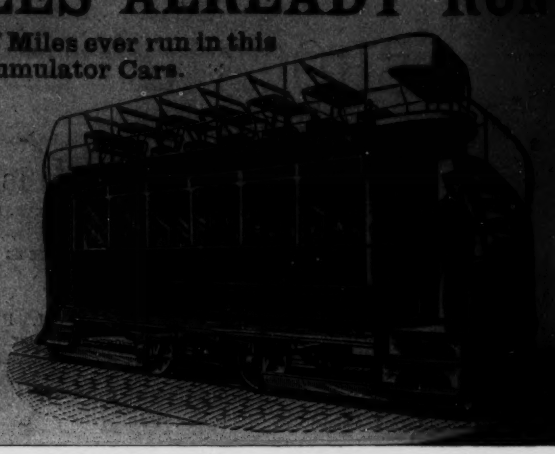

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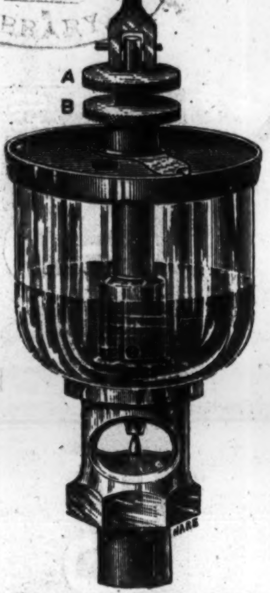

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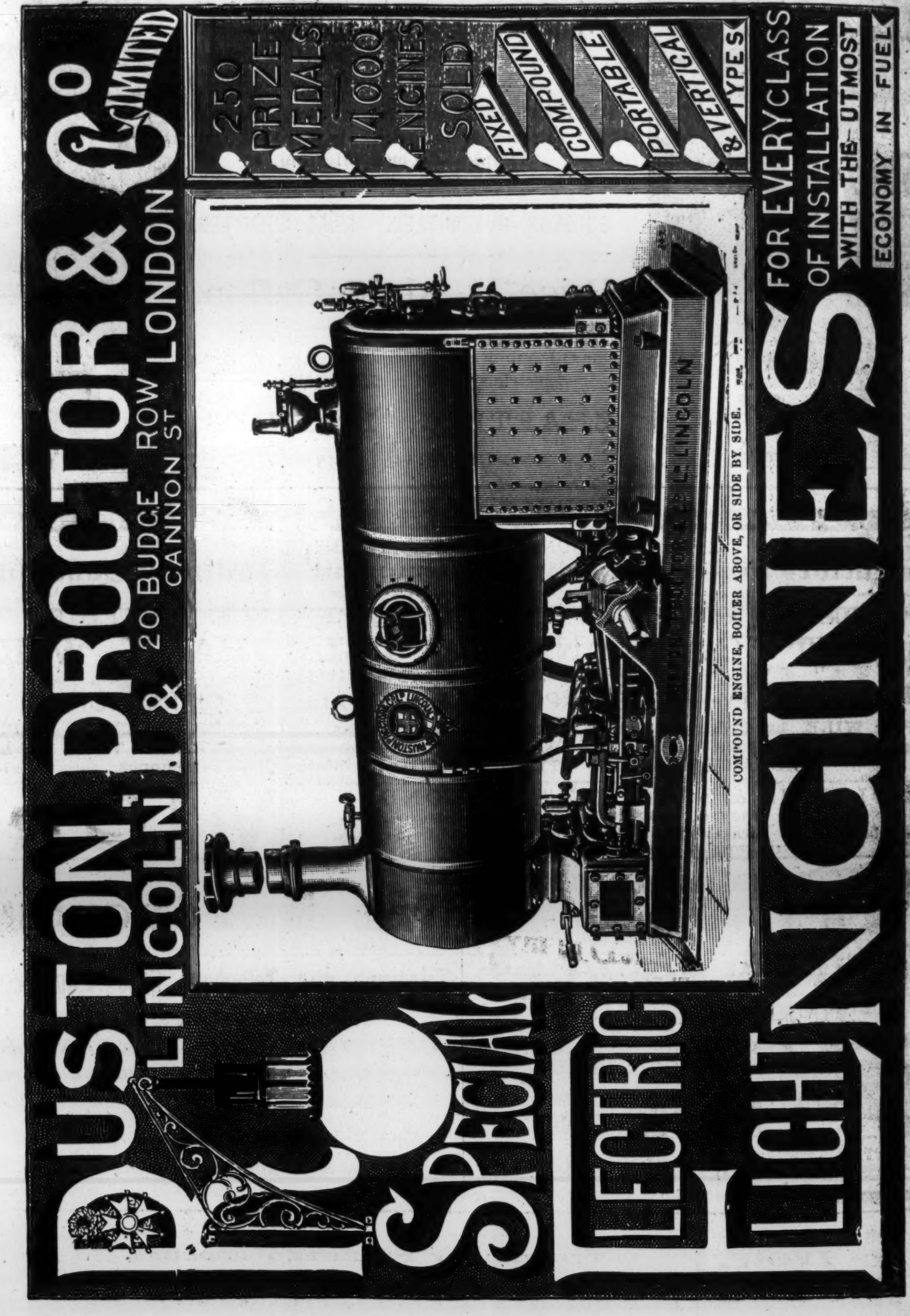

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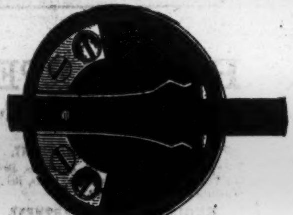

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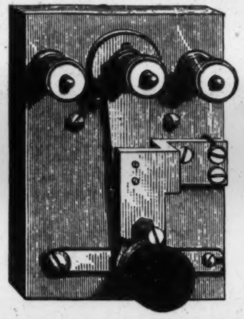

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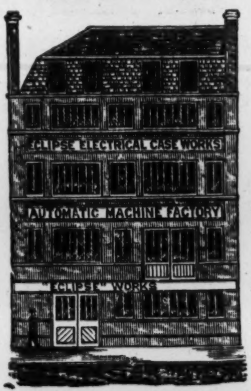

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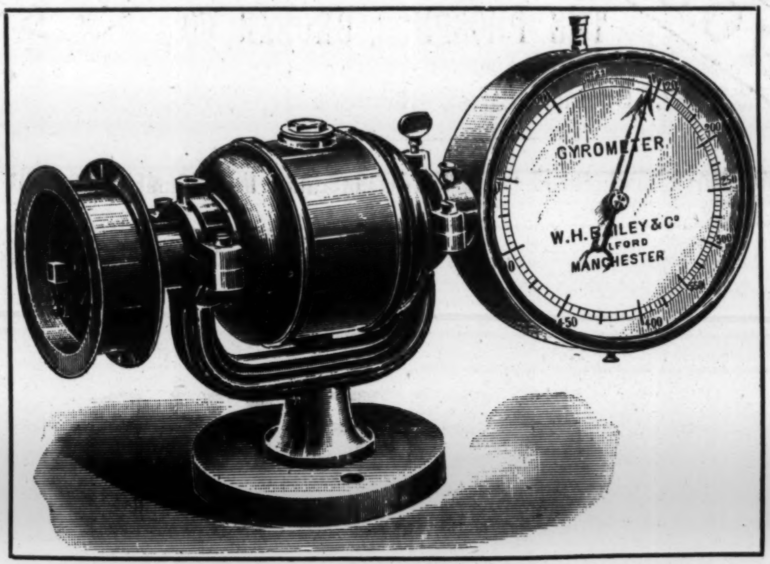

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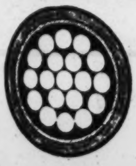

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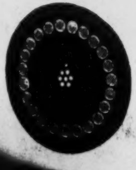

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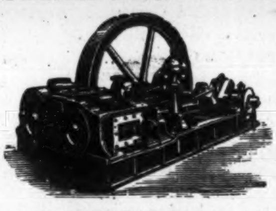

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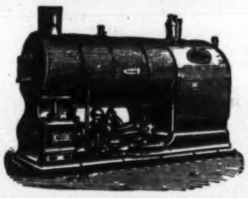

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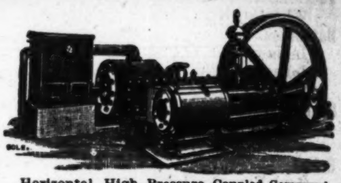

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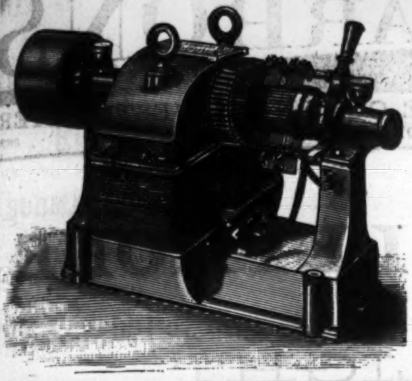

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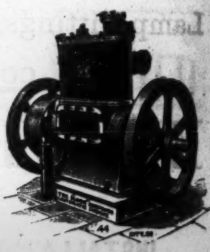

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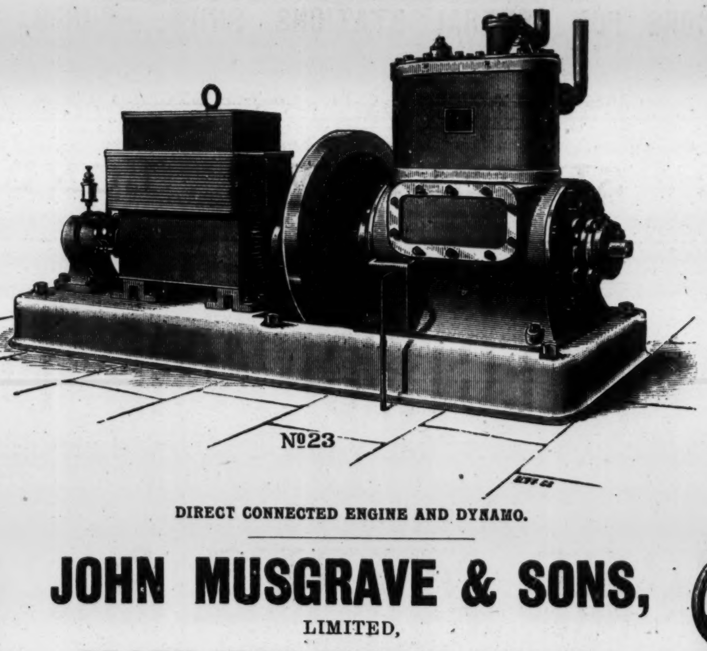

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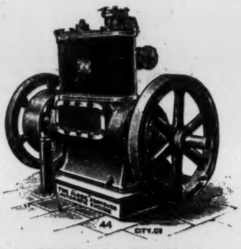

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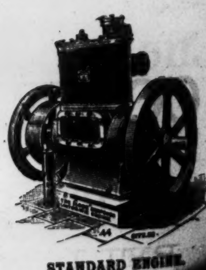

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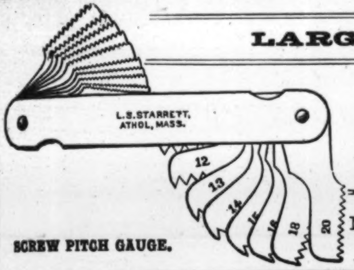

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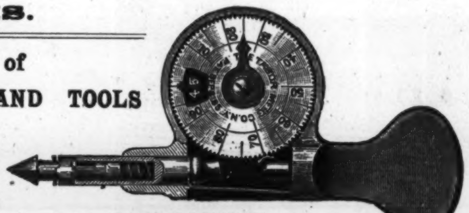

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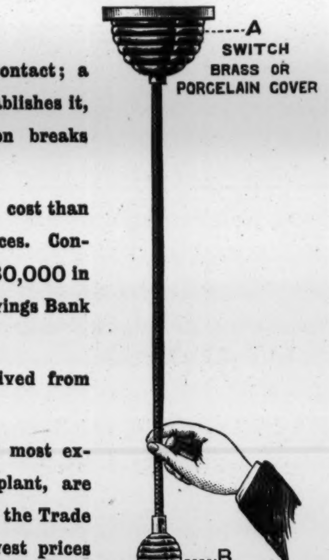

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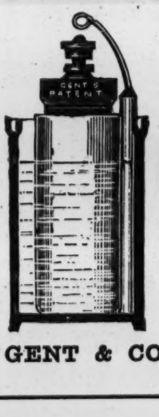

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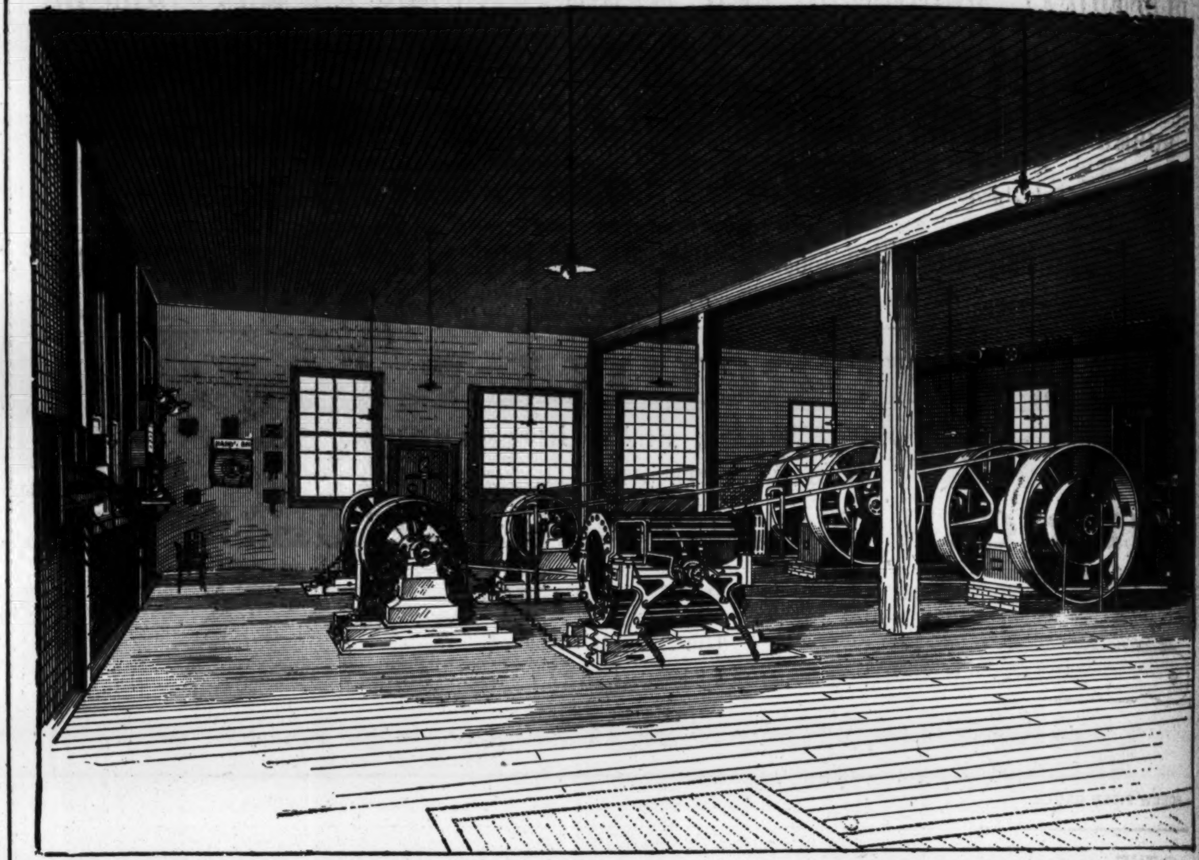

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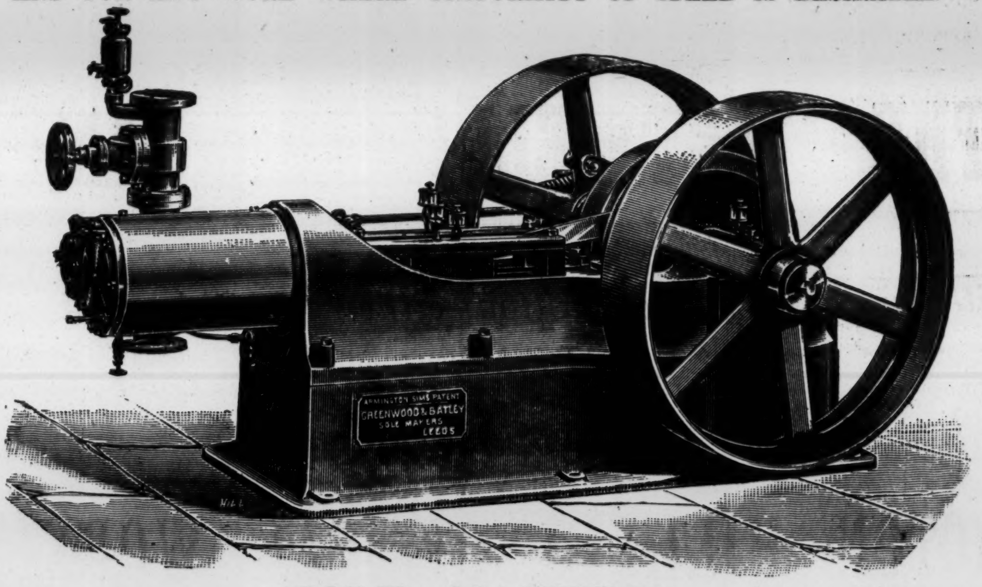

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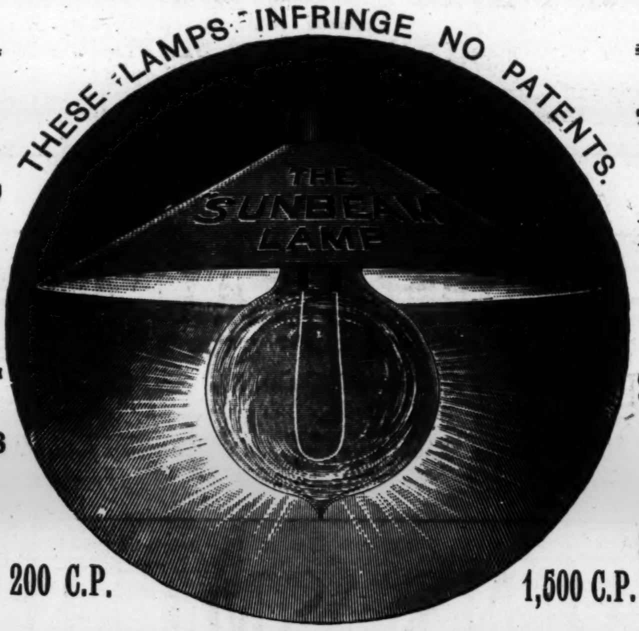
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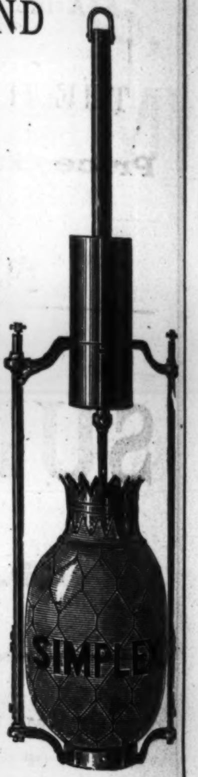

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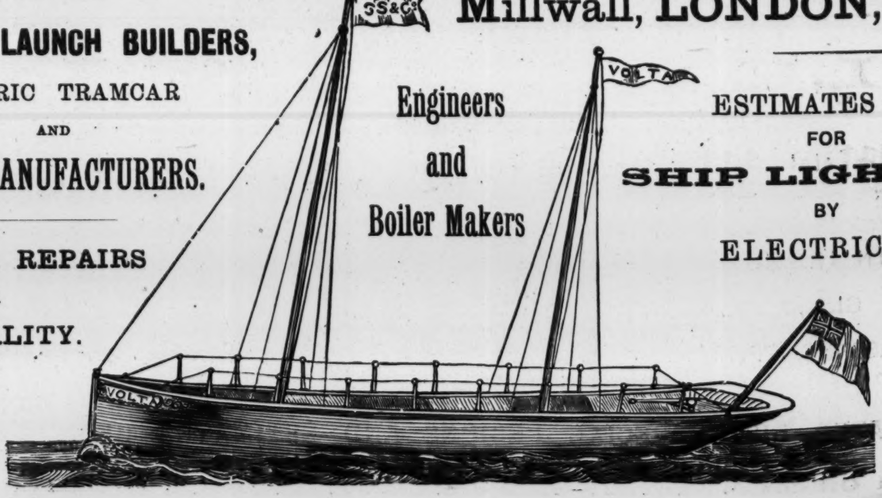

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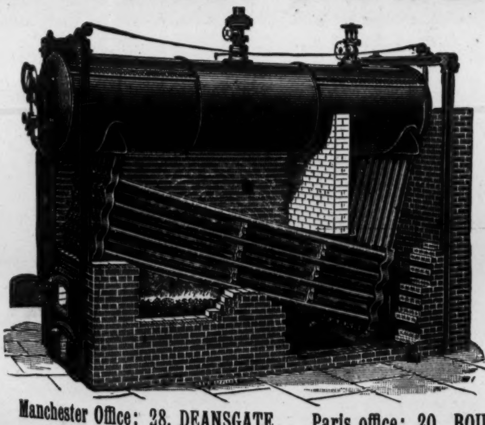

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ELECTRICAL REVIEW.

VOL. XXVI. MARCH 28, 1890. No. 644.

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TINNED COPPER WIRE.

IN the initial stages of submarine telegraphy there were some differences of opinion on the advantages of galvanising the external protecting wires of the cables, and experience has shown the desirability of galvanising, not only the wires of submarine cables, but also the ordinary telegraph wire for overhead purposes. A discussion on the advisability of tinning copper wires when insulated with India-rubber is not unlikely to arise, when so many instances are occurring, which point, most unmistakably, to tinning being the the cause of many faults.

It was found in the early days that when wires were insulated with rubber and then vulcanised, that the sulphur immediately attacked the copper, and various substances, such as varnishes and the like, were used to prevent this action; it was not, however, until the latter part of 1860 that tin was applied to wire as a remedy. Copper wires thus protected have since been invariably used with all *vulcanised* rubber cables, and latterly, since electric lighting has so greatly advanced, all wires insulated with rubber, whether pure or vulcanised, have been so treated. Whether this is wise or not experience is beginning to show, but as regards the use of tinned wires for pure rubber its adoption has become general from other causes.

The action of sulphur upon copper was, perhaps, earliest seen in the days when gutta-percha was first employed as an insulator; it was at the commencement that the pure gum was mixed with sulphur as an "improvement," but very soon it was found that the action of the sulphur on the copper wire was of such a character as to destroy it, and form a combination which was the accidental discovery of the well-known "Statham's fuse." Early telegraphists will, doubtless, recollect this form of gutta-percha covered wire and the facility with which these fuses could be made from ordinary G.P. wire. It is needless to remark that as an insulator for covering wires, gutta-percha and sulphur have not since been allied.

With vulcanised rubber cables the tinning has been found to be a great advantage, for although the wires are covered with pure rubber and separators, the active agent, sulphur, still penetrates, and if a vulcanised cable, no matter how new, be opened and examined, the action of the sulphur on the tinning will at once be perceived; but the mischief does not proceed far.

Originally, for electric light purposes, a very large amount of wire was used which was insulated with pure rubber, and for this purpose the wire was not tinned. A considerable quantity of the same class of wire is being employed at the present time; but this is now invariably tinned, and always particularly specified to be so. There has not been, so far as we are aware, any change whatever in the quality of the rubber employed, which has been of the kind known as "pure," without any admixture of sulphur, so the alteration could not be on that account. The reason, however, why the change has been made is really that the ends of a tinned wire are so much easier to *solder* into a proper joint than when untinned. It simply means that while a workman is required to properly joint and solder two plain wires, any "duffer" can solder the tinned ends. When the progess of electric lighting advanced with rapid strides, bad joints soon showed themselves as being the natural result of the class of men introduced into the "wiring" or installation work, and the facility of jointing tinned wires soon became evident. It was, therefore, considered necessary that the whole length of the wire should be tinned throughout, in order that joints should be readily made by the class of men employed at the points required, as good workmen and good jointers were not to be obtained in sufficient numbers, and it was also found to be economical to employ the first mentioned class of labour. As the desired quality of wire was to be obtained at the same price as the plain, it was not surprising that the electric light engineer specified invariably for tinned wire, knowing that the jointing and splicing became matters of less difficulty and avoided the necessity of employing higher class workmen, for it must be admitted that the making and soldering a joint or splice in a heavy electric light main where the wires are not so prepared is a matter of difficulty, requiring much skill in the making and a more than general knowledge of soldering. Samples of many such joints have proved to us the great difficulty of making a good and neat junction, and also the still greater difficulty of soldering it when made.

It is granted, therefore, that the tinning has been a great advantage from this point of view, and that installation work has been much facilitated thereby, although we must express some regret that the good jointer and wireman is not so frequently met with as before. But, whilst acknowledging these points we must confess that, judging from facts which are constantly coming to our knowledge, this tinning is not an "unmixed blessing." How is it that faults are constantly occurring in installations where tinned wire is used which could never have happened with *plain* wire? From every kind of installation and from every quarter samples of these faults come to us; without warning a circuit suddenly fails, and the fault is found in the wire eaten through and destroyed, leaving certain traces. In damp and dry places, in bleach works or dye works where the air is full of corroding vapours, and in works where there is no moisture, but only dryness, the same kind of faults appear. We have seen the class of fault in badly made joints where spirits of salts have been too freely used, and no precaution taken to remove them. Those who have noticed these joints steadily eaten away will understand what is meant when we mention that the faults alluded to in the tinned wires are of a precisely similar character. An examination of the wire where such a fault has occurred will in all probability show the active agent in various stages of progress. Many of these faults have been shown to us which have happened in works where the air is full of an active vapour sufficient to have had complete effect on the wire if it had been unprotected; but all examinations showed that the action had taken place from the wire *outwards*, and not from the actively charged air *inwards* to the wire. The fault is not in the insulation which covers the wire, it is not in the copper conductor itself, it is in that which has rendered jointing more easy; the fault is in the *tinning*.

The growth of electric lighting has caused so large a demand for wire that our manufacturers have with difficulty kept the supply equal to the demand. And as the manufacture of tinned wire is one of more time, it is not improbable that in this the latest stage sufficient care is not exercised in the thorough cleansing of the wire after it has passed through the tinning process. It is known that before being tinned the wire has to pass through a strong agent to cleanse it and to prepare it for taking the coating as it passes through the bath. Should any of this active solution be left in the wire it will, on account of its nature, assuredly remain on and not dry off, and if such be the condition of the wire, whilst being insulated, it is easy to follow the action which subsequently takes place, resulting in the faults to which we call attention.

From the result of the observations which have been made, this is, without any doubt, the true reason of the faults, and very great damage will be done to the electric lighting interest unless the causes of such failures are at once removed. Those who tin the wire should adopt some process which will prevent such occurrences happening in the future; and those who cover it with insulating material should first ensure its dryness. Without such precautions we are inclined to think that there is more safety in plain copper wire in the hands of skilled workmen.

EARTH CURRENTS AND THE OCCURRENCE OF GOLD.

In connection with the study of earth currents, we would call the attention of our readers to an article in the issue of *Nature* for March 20th, written by Mr. George Sutherland, wherein the author advances the suggestion that the deposition of drift gold may be attributed in some measure to the agency of earth currents.

The argument is, that the occurrence of drift gold cannot be explained by the "detrital" hypothesis, and that in alluvial drifts there was always a certain proportion of gold which had its source in some other origin than the breaking down of quartz reefs by the ordinary processes of nature. Beyond this, it is now generally admitted by scientific authorities, that the alluvial drift gold has not only been formed in its present position, but is actually accumulating.

It seems probable that drift gold has its origin in the salts held in solution by water, and the most common salt of the precious metal is chloride of gold. Precipitation does not account for the manner in which the gold has been reduced from its salts and deposited either in the form of grains or of nuggets; nor does the theory hold good that a miniature electric battery is formed, in which gold would form one pole and iron pyrites the other, and the current passing between the two deposits metallic gold.

The author goes on to suggest that the probable origin of the deposition of gold is to be found in thermo-electric earth currents generated by the unequal heating of the surface of the earth by the sun's rays passing from east to west, and the following appear to be the principal reasons for this opinion:—(1). Earth currents appear to be most pronounced along water courses. (2). Strong currents are especially noticeable at the junction of permeable and impermeable rocks. (3). There is a remarkable relation between the conductivity of the adjacent rock country and the richness of an alluvial drift, suggesting that where an earth current is concentrated along the line of water in consequence of the presence of rocks of low conductivity, the process of deposition has been facilitated. (5). At particular pinched localities the current would be particularly strong, and thus account for the formation of nodules or nuggets. (6). An alloy of gold and copper has been met with, and the two metals have been found in alternate layers, suggesting that at one time a copper salt, and at another a gold salt, has been subjected to the action of a reducing current. (7). In presence of organic matter a drift becomes especially rich. The formation of acid by decomposition would facilitate the passage of earth currents, free acid being necessary for an artificial electro-depositing bath. (8). Calcite is inimical to the richness of a drift; the carbonate of lime destroying the free acid, would reduce the conductivity of the water and thus impede transmission of current. (9). Electric action of an extraneous nature is indicated by the strings and filaments of gold constantly met with. (11). The large masses of gold sometimes found with quartz where the reefs become narrow in pinched localities may be traced to earth currents, since in such a locality while the formation of quartz would be retarded, the formation of gold would be accelerated by the concentration of the current.

Length of the Voltaic Arc.

VERY few experiments have as yet been made to determine the variations in the length of the voltaic arc when the nature of the surrounding atmosphere is taken into consideration. M. Villari has, however, recently taken up this study and has obtained varying results. Taking $\frac{1}{6}$th of an inch as one length of the arc in a hydrogenous atmosphere, he found that the same arc in oxygen was $\frac{5}{16}$th inch, and in ordinary air, $\frac{1}{3}$rd inch. In these trials the carbons were placed horizontally; but if vertical carbons, as in ordinary arc lamps, are used, the results are entirely different and the arc is considerably longer. This result is specially the case when the positive carbon is above the negative, that is to say, if the current passes downwards. In the latter case M. Villari discovered that the arc produced in oxygen was 25·7 times greater than that obtained in hydrogen. If, however, the positive carbon is placed below the negative, that is, with an ascending current, the difference is less noticeable, and the arc produced in oxygen is only seven times greater than that in hydrogen.

Underground Wires.

THE general opinion regarding the proper laying down of underground wires in the States where the greatest experience has been gained, now appears to be in favour of constructing special and separate subways or conduits for them and allowing water, gas and other pipes to remain as they are. We believe that this is the right course to pursue.

Newspaper Science.

IN a series of two articles written recently to the *Glasgow Herald* by Mr. M. David Cook, we have the subject of "The Dangers of Electric Lighting" discoursed upon. The writer, whilst putting the subject dealt with in a sensible and practical manner, has decidedly overshot the mark with reference to the suggested utilisation of the power expended at the Clyde falls. He speaks about "thousands and thousands of horse-power" being available for lighting the cities of Edinburgh and Glasgow by the electric light. We wonder whether Mr. Cook has made even a rough calculation as to the actual power obtainable from water. As a letter from this gentleman appears in our Correspondence columns, we have no occasion to go into the details to which we alluded in our last.

Electric Lighting and Public Safety.

MR. GEORGE WESTINGHOUSE, in the March number of the *North American Review*, will not allow that any method except that of the alternate current transformer system is safe for general distribution in cities. He bases his faith on the assumption that the insulation in the converter allows of an absolute separation of the street mains from the house wires. One would have thought that his own experience would have shown that his confidence in the integrity of the insulation was misplaced.

A Request.

THE managers of the technico-industrial review, *l'Elettricita*, published at Milan, Italy, will be greatly obliged if persons possessing the requisite electrical knowledge will kindly communicate, either directly or through the ELECTRICAL REVIEW, their opinion upon the two following questions:—1. What has been the most important invention, discovery or scientific work of the past year, in the domain of electricity? 2. What amongst known electrical appliances will probably be the most in vogue during the present year? Answers, which will be published in next months number of *l'Elettricita*, are earnestly requested.

Elmore's Copper.

ONE way to compete with this electrolytically formed copper wire of high conductivity would be to give the purchaser a slightly greater weight of conductor than he actually asks for. That is to say if the company recently formed to exploit Mr. Elmore's process thinks it is going to secure the monopoly of the wire market by producing a material with a two or three per cent. greater conductivity than other manufacturers can supply, the deficiency will be made up by competitors giving a slightly greater weight of copper. Naturally these remarks are based upon the assumption that the Elmore wire will be priced like other copper in the market, for if higher, users will find it cheapest in the long run to use, so far as conductivity is concerned, slightly inferior copper, of somewhat heavier weight.

Specific Inductive Capacity.

WE would draw attention to the letter of Mr. Kingsbury in our Correspondence columns. Not many weeks ago, Prof. Chas. Cross was obliged to publicly disclaim all knowledge of a paper on transformers supposed to be sealed with his authority; now, perhaps, when Dr. Jacques has read our correspondent's replies to the article published by us last week, we shall have yet another disclaimer.

ON THE EXCITEMENT OF ELECTRICITY AND HEAT IN ELECTROLYTES.

By MAX PLANCK (*Annalen der Physik in Chemie*).

WHILST our knowledge on electric conduction in metals is so uncertain that very heterogeneous views may still co-exist, a minute insight into the corresponding processes in electrolytic conductors has recently become possible. The advance is due, in the first place, to the researches of F. Kohlrausch on the conductivity of aqueous solutions in conjunction with Hittorf's determinations of the transport figures of the ions. Hence, as Kohlrausch has shown, both the absolute velocity of the ions in a given current can be calculated and their moveability, *i.e.*, the speed which a grm. ion in an aqueous solution possesses under the action of the mechanical power 1, only presupposing that the conduction of electricity is effected not by the water, but exclusively by the ions which, according to the law of Faraday, travel with constant charges.

The latter supposition has been modified by Arrhenius to the effect that, of the molecules of the dissolved matters, only a fraction, *i.e.*, those dissociated into their ions, take part in the conduction of the electricity. Thus the increase of the molecular conductivity along with dilution is explained not by increased moveability, but by the increased number of the conductive ions. The law of the dependence of conductive power on dilution, thence derived, has been especially confirmed by Ostwald. All the relations for solutions infinitely diluted are the most simple, as in them all the dissolved molecules are dissociated and can therefore participate equally in the conduction of the electricity. The safest conclusions can therefore in future be connected with the behaviour of infinitely diluted solutions.

Whilst thus the forces and motive processes within a solution of uniform concentration traversed by a current have been made accessible to calculation, the phenomena in solutions of unequal concentration become decidedly more complicated by the accession of diffusion. But even here an insight into the mechanism of the ions seems to be rendered possible by a regard to osmotic pressure introduced into the theory of solutions by Van't Hoff, which fully conforms to the laws of gases and must be supposed to act as a partial pressure between the ions of every kind.

Nernst, from the joint action of the osmotic partial pressures and the electrostatic forces proceeding from the charges of the ions, has not only calculated the absolute coefficients of diffusion in very noteworthy agreement with direct observations, but he has deduced expressions for the electrical differences of tension occurring in solutions of unequal concentration, which completely agree with all experiments as well as with the theory of chains of concentration developed by H. von Helmholtz.

The efficacy of the electrostatic forces was taken into account by Nernst by means of the assumption that no free electricity can appear in the interior of the solution. This assumption agrees very closely to the laws of electrostatics and is fully adequate to Nernst's purpose. But it can be accurate only if the charges of the ions, measured electrostatically are infinitely great. But as the ions possess indeed very great, but still finite electrostatic charges it follows that before the electric forces can come into action a finite definable quantity of free electricity must be formed in the solution.

It, therefore, appears interesting to examine what conclusions, under the circumstances are necessitated by a strict application of the known principles of electrostatics and hydrodynamics in the general case of a solution of many electrolytes, traversed at once by any given galvanic currents. The results are laid down in the following researches. Besides the diffusion and the excitation of electricity, the thermic effects are considered, in which the principle of energy gives scope for peculiar conclusions.

Section 1.—*Transfer of the Ions and Electricity.*

We consider an aqueous solution of any given binary electrolytes of uniform temperature but of unequal concentration. The dilution may be carried so far that no notice need be taken of the behaviour of the non-dissociated molecules. This condition is the more closely approached the more slowly the molecular conductivity increases with increasing dilution.

The composition of the solution at any moment is known when the osmotic pressures $p, p', p'' \ldots$ of all kinds of positive ions, as well as $q, q', q'' \ldots$ of the negative ions are given at each point of space, x, y, z. Every inequality of one of these partial pressures gives a force which seeks to drive the ion in question from a higher to a lower pressure. In addition there come into consideration the attractive and repelling forces exerted upon the electric charges of the ions by the free electricity within and without the solution, according to the general laws of electrostatics.

There are now in the spacial element $d\,\tau$ $(p/\mathrm{R})\,d\,\tau$ positive grms. ions of the first kind, when R indicates the osmotic pressure of a grm. ion in the Volume I., a constant independent of the nature of the ion. Upon these ions the osmotic force acts in any given direction ν with the component $-(\delta\,p/\delta\,\nu)\,d\,\tau$; the electric force acts also in the same direction with the component $(\delta\,\phi/\delta\,\nu)\,.\,\varepsilon\,.\,(p/\mathrm{R})\,d\,\tau$, when ϕ indicates the potential function of all the free electricities, and ε the electric charge of a positive grm. of ion. There acts then upon a single ion in the direction ν the component force $-(\mathrm{R}/p)\,(\delta\,p/\delta\,\nu) - \varepsilon\,(\delta\,\phi/\delta\,\nu)$. The moveabilities of the single kinds of ions, *i.e.*, the speed which a grm. ion assumes under the influence of the mechanical force 1 in the solvent may now be indicated by $u, u', u'' \ldots$ for the positive ions, and by v, v', v'' for the negative ions. There then results the ν component of the speed of the positive ions in question by multiplying the above force by u, and finally, as the number of these ions contained in the volume 1 is p/R, that number of the positive ions of the first kind which passes in the time, $d\,t$, through a plane, $d\,\sigma$, towards the positive side of the normals, ν, as

$$-u\left(\frac{\delta\,p}{\delta\,\nu} + \varepsilon\,\frac{p\,\delta\,\phi}{\mathrm{R}\,\delta\,\nu}\right) d\,\sigma\,d\,t. \qquad (1)$$

Similar expressions hold good for the other kinds of partial pressure, $p', p'' \ldots$ and the moveabilities $u', u'' \ldots$ where the magnitudes ϕ, ε and R retain their signification in all expressions. On the other hand, for the negative ions with the partial pressure q and the moveability v the expression for the number flowing through $d\,\sigma$ in the same direction is

$$-v\left(\frac{\delta\,q}{\delta\,\nu} - \varepsilon\,\frac{q}{\mathrm{R}}\,\frac{\delta\,\phi}{\delta\,\nu}\right) d\,\sigma\,d\,t$$

and similarly for the other kinds.

If we seek the total number of the ions (positive and negative) passing in the time $d\,t$ the plane $d\,\sigma$ in the direction, ν, it is found by the addition of all the corresponding expressions. If, for abbreviation, we put

$$\mathrm{U} = u\,p + u'\,p' + u''\,p'' + \ldots.$$

$$\mathrm{V} = v\,q + v'\,q' + v''\,q'' + \ldots.$$

$$-\left\{\delta\left(\frac{\mathrm{U}+\mathrm{V}}{\delta\,\nu}\right) + \frac{\varepsilon}{\mathrm{R}}\,(\mathrm{U}-\mathrm{V})\,\frac{\delta\,\phi}{\delta\,\nu}\right\} d\,\sigma\,.\,d\,t.$$

Hence the total number of the ions which pass in the time 1 through a surface, 1, towards the positive side of the space normals ν, is

$$-\left\{\frac{\delta\,(\mathrm{U}+\mathrm{V})}{\delta\,\nu} + \frac{\varepsilon}{\mathrm{R}}\,(\mathrm{U}-\mathrm{V})\,\frac{\delta\,\phi}{\delta\,\nu}\right\} = \mathrm{N}\nu. \qquad (2)$$

Hence the number of the ions travelling in the opposite direction has to be deducted as negative.

On the other hand, for the quantity of electricity passing through $d\,\sigma$, as each positive ion carries with it the charge ε, and each negative the charge $-\varepsilon$, we have the expression

$$-\varepsilon\left\{\frac{\delta\,(U - V)}{\delta\,\nu} + \frac{\varepsilon}{R}\,(U + V)\,\frac{\delta\,\phi}{\delta\,\nu}\right\}\delta\,\sigma\,\delta\,t.$$

so that the component of the specific intensity of current in the direction ν is represented by:

$$-\varepsilon\left\{\frac{\delta\,(U - V)}{\delta\,\nu} + \frac{\varepsilon}{R}\,(U + V)\,\frac{\delta\,\phi}{\delta\,\nu}\right\} = J\nu. \quad (3)$$

If this equation is put in the form:

$$J\,\nu\,.\,\left[\frac{\varepsilon^2}{R}\,(U + V)\right] = -\frac{\delta\,\phi}{\delta\,\nu} - \frac{R}{\varepsilon}\,\delta\,\frac{\dfrac{(U - V)}{\delta\,\nu}}{U + U} \quad (4)$$

and compared with Ohm's law, it results that the specific conductivity of the solution $= \varepsilon^2/R\,.\,(U + V)$ and further, that in a solution of unequal concentration, besides the fall of potential there is in action another local electromotive force, the magnitude of which is determined by the last expression in the above equation. Hence, in the absence of a current, there must occur a given fall of potential.

(*To be continued.*)

LIGHTNING CONDUCTORS.

By S. ALFRED VARLEY.

(*Continued from page* 321.)

Dynamos deal with energy in the form of matter in motion, such motion being imparted and *maintained* by *an expenditure* of force; the matter in motion (the revolving armature) encounters the resistance of magnetic inertia developed in the magnetic field, and a transformation of energy is brought about, much in the same way as when a rifle bullet, moving at a high rate of velocity, meets with resistance in its path, and becomes buried, say, in the trunk of a tree. The only difference between what occurs when a bullet discharged from a rifle is arrested by a tree, and what takes place when the revolving armature of a dynamo is being moved through the magnetic field, is that the resistance the mass of wood opposes to the motion of the bullet sets up heat motion, whereas the resistance encountered in a magnetic field produces electrical motion. It is desired to emphasise *strongly* that the transformation of energy brought about by arresting the motion of the rifle bullet, as well as that which occurs in a dynamo, arises from the inertia of matter in motion being overcome by the inertia of a heavier mass of matter in a condition of rest; and it is *in the* matter whose inertia has been overcome where the transformation of energy occurs.

It has been claimed for the dynamo that it is the most perfect of machines, because it deals more directly than other machines do with the two great principles which underlie all physical acts. A rifle bullet, whose motion becomes arrested by a tree, encounters not only inertia, but the cohesive force binding together the fibres of the wood, which it overcomes to a considerable extent, and in a degree proportionate to the cohesive force that is overcome by the moving bullet, heat motion will be set up in the tree.

The resistance which a magnetic field opposes to matter in motion is inertia pure and simple, apart from *any of the other* forces associated with matter, and therefore the transformation of the energy of matter in motion into electric motion is very complete, and it would seem that given the rate of motion of the moving armature, and the resistance of the circuit are maintained constant, the transformation of energy which occurs should take place *wholly* in the moving matter whose motion is resisted, and not at all in the stationary matter of the dynamo, where no work whatever is being done; but if sudden changes of resistance in the circuit occur, or if the motion imparted to the revolving armature be irregular, then a transformation of energy to a greater or less degree will take place in the stationary matter of the dynamo.

The energy associated with matter in motion becomes transformed in the dynamo into electric motion in the circuit. Conductors oppose resistance to the motion of electricity through them, much in the same way as wood resists the passage through it of a moving bullet, and precisely as heat will be developed in a tree proportionately to the cohesive force overcome by a rifle bullet, so heat, corresponding to the resistance which has been overcome, will be developed in the circuit through which the electricity is moving.

Close a galvanic battery through a long telegraph circuit earthed in the usual way, and four things happen:—

1. Induction between the insulated conductor and the earth occurs through the medium of the dielectric, and a statical charge is accumulated.
2. Magnetic polarisation is developed in the conductor.
3. Electricity passes dynamically.
4. Zinc and chemicals are consumed all the time the circuit is closed.

The accumulation of a statical charge and the development of magnetism involve a definite consumption in the battery, but such consumption is represented by energy occluded in the circuit during the time electricity is passing dynamically, and it remains occluded until such time when the circuit is opened, and then the energy which has been occluded statically becomes transformed into dynamic electricity and is dissipated through the medium of current which it sets up.

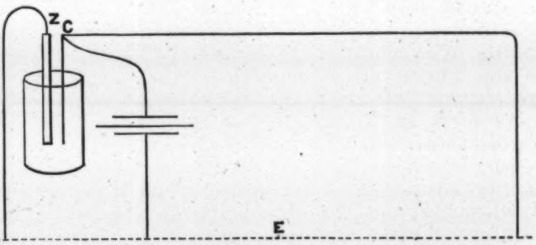

FIG. 13.

Connect, as indicated in fig. 13, one set of the metallic surfaces of a condenser to the battery end of the telegraph wire, and connect the opposite surfaces to the earth, no current will pass through the condenser, but a further occlusion or storage of energy involving a temporary increased rate of consumption in the battery will occur, such increased consumption being accounted for in energy statically occluded in the condenser. So soon as the potential of the statical charge accumulated becomes equal to the difference of electrical potential existing between the earth and the battery end of the telegraph wire, the consumption of material in the battery will proceed at the same rate as before the condenser was interposed, and the only limit to the amount of energy which may be statically occluded in the manner indicated is the inductive capacity of the condenser.

The development of magnetism in the soft iron core of an electro-magnet is equally a storage of energy as is the accumulation of a statical charge in a condenser or a Leyden jar, and, therefore, magnetic polarisation may be regarded as energy statically occluded.

The amount of energy that iron is capable of occluding is directly as its storage capacity, the storage capacity increases as the mass and the softer and purer the iron the greater its specific storage capacity.

The maintenance of magnetic polarisation involves no expenditure of energy any more than does the maintenance of magnetism in tempered steel magnets or the maintenance of a statical charge in a condenser.

There are, however, distinctive differences between the occlusion of energy in iron when it assumes the form of magnetic polarisation, and the occlusion of energy in a condenser developing electricity in the form of a statical charge.

The energy occluded is the same in both cases, but energy, when associated with matter developing magnetic polarisation, seems to be more material than when it is associated with the electricity of matter producing a statical electrical charge.

When a condenser is interposed between the opposite poles of a galvanic battery, energy rushes into it, much in the same way as compressed air in a closed vessel connected by a stop-cock with a vacuous chamber, rushes into the empty space when the cock is opened; at first there is no impediment opposed to the inrush of the compressed air, but, as the empty chamber fills, resistance is opposed, and this resistance increases until the pressures in the two vessels become equal to one another; and so it is with an uncharged condenser, the resistance it opposes to the reception of statical charge increases as the square of the potential of the charge accumulated.

Now, when a galvanic battery circuit surrounding a mass of soft iron is closed and energy becomes statically occluded in the iron developing magnetism, a very perceptible time is occupied in such storage, and during the time energy is being occluded, great resistance is opposed to the development of current by the battery, the inertia of the iron opposes resistance to a sudden change from its normal unmagnetic state to the magnetically polar condition and the resistance it opposes to a change of condition causes it to endeavour to set up a current in the circuit in an opposite direction to that which the galvanic battery is developing, the action is suggestive of what is experienced when setting machinery having a large flywheel into motion, the bigger and heavier the wheel the greater the time consumed in setting up rapid motion, and the longer the time also required to stop the motion after the inertia of a condition of rest has by energy imparted to the wheel and other parts of the machinery been transformed into the inertia of motion.

As long as the speed of a machine is kept at a uniform rate, whatever may be the amount of energy consumed in performing work, no expenditure of energy is involved in maintaining the motion of the flywheel beyond that incidental to friction at the bearings and the skin resistance of air; and so it is with a dynamo, the transition of the iron of the field magnets from the passive to a magnetically-polarised condition, brought about by an occlusion of energy, involves time; but there is no expenditure of energy in maintaining the polarised condition after it has been developed; still in the same way as there is incidentally the resistance of friction in the case of the flywheel, so there is also a small incidental loss of energy in a dynamo, due to the electrical resistance of the insulated convolutions surrounding the soft iron field magnets.

The field magnets of a dynamo must not, however, be regarded as the analogue of the flywheel of a steam engine; they resemble a flywheel so far that they are masses of matter in which energy is stored, and the field magnets comport themselves similarly to a flywheel in reference to sudden changes of condition, because magnetic inertia and terrestrial inertia are forces associated with matter largely resembling one another; but that is the chief, if not the only, resemblance which exists between the flywheel of an engine and the field magnets of a dynamo. The magnetic inertia developed in a magnetic field may be more truly regarded as the analogue of the inertia of a mass of matter in a condition of rest resisting the inertia of matter in motion, and forming the resisting fulcrum of the machine.

When a dynamo is driven at a uniform speed, and the resistance of the circuit is maintained constant, the magnetic field opposes a definite amount of resistance to the motion of the revolving armature, and current developed at a uniform rate passes through the circuit and round the field magnets in a constant direction. The armature also revolves in a constant direction through the field, but the direction of the magnetic polarisation in the molecules of the iron of the armature and the direction of the current developed in the insulated armature convolutions are continually being reversed.

The superior inertia of the massive field magnets opposes a passive resistance to a change of condition far greater than the moving parts (the armature) do, and, therefore, the changes of direction of magnetic polarisation take place wholly in the armature, and the transformation of energy occurs in the insulated convolutions surrounding it.

The matter composing the revolving armature does, however, oppose a very considerable resistance to sudden changes in the direction of magnetic polarisation, and such resistance is only overcome by the expenditure of mechanical force, energy corresponding to this expenditure becoming transformed into electrical motion.

The energy which is transformed during the passage of the armature through the magnetic field of a dynamo corresponds to the inertia opposed to the armature, and it will be greater inversely as the magnetic inertia of the *whole* of the active moving matter is less than the inertia of the stationary field magnets, and inversely also as the magnetic inertia of the convolutions of insulated wire of the armature *is less* than that of the iron they surround, and therefore the smaller the self-induction of the armature convolutions the less the tendency to spark.

Within defined limits, the higher the velocity of the revolving armature the greater the inertia developed in the magnetic field, and the greater the amount of energy transformed and transmitted through a constant resistance, but an increased rate of motion increases the magnetic inertia of the iron of the armature and its convolutions of insulated wire, in the same ratio as that of the magnetic field, and, therefore, within certain limits the relative difference of the respective inertias of the moving and the stationery matter of a dynamo will remain fairly constant, and the transformation of energy that occurs, is consequently, directly as the speed.

The magnetic inertia of a mass of iron equally with its terrestrial inertia is a definite quantity which cannot possibly be added to, and, therefore, as already stated, the inertia capable of being developed in a magnetic field is determined ultimately by its weight.

When the magnetic polarisation of the field magnets approaches saturation, the inertia of the field will be approaching its highest limit, and this stage will be arrived at before the revolving armature and its convolutions have reached the limit of the inertia capable of being developed in them,* and as the inertia of the magnetic field remains stationary after its limit has been reached, it follows that if the velocity of the revolving armature be further raised the effect is to reduce the relative differences of the inertias of the moving and stationery matter, and as a consequence the magnetic inertia of the armature re-acts on the field, driving back the magnetic poles of the field magnets, the inertia of the field becomes less, and no advantage is obtained from the increased rate of motion.

The driving back of the magnetic poles by inertia developed in the revolving armature and consequent weakening of the field is very noticeable in separately excited dynamos. The writer observed it in a very marked degree in the large Gramme machines of the earlier type, and he called attention to it shortly after they were first introduced into this country; the machines he alludes to had two armatures, one of which was closed through the field magnets of the machine, and the other developed the energy which was transmitted.

The leading and distinctive features of a dynamo, according to the view of the writer, may be summed up as follow:—

1. The resisting fulcrum or base of the machine—viz., the inertia of the field—has to be developed, and this development of magnetic inertia involves an occlusion of energy eventually dissipated by the development of what used to be termed "extra current."

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* The heat developed in the dynamo, which is practically a disturbing element and limits the output of the machines, has not been taken into consideration.

2. That the energy occluded in the field magnets is a purely statical occlusion very analogous to the occlusion of energy in a charged Leyden jar.

3. That the arc or spark produced when a dynamo or any electrical circuit is divided arises from the dissipation of the energy occluded, and is strictly analogous to that of a Leyden jar discharge.

4. That theoretically no cost is involved in maintaining the occlusion of energy represented by the magnetic polarisation of the field magnets any more than there is in the maintenance of occluded energy represented by the motion imparted to a flywheel.

5. That the small expenditure which in practice occurs both in the case of the field magnets of a dynamo and the flywheel of an engine are simply incidental to conductive resistance in the one case and skin resistance and friction at the bearings in the other.

6. That the transformation of energy in a dynamo corresponds to the inertia the revolving armature opposes to sudden changes in the direction of magnetic polarity, and such inertia is sustained by the current set up in the armature convolutions, similarly as the inertia of the field is maintained by the current circulating round the field magnets, and the practical result is, that energy equal in amount to the negative energy, or inertia resistance of the revolving armature, becomes deflected through the medium of current developed in the circuit, and, further, the work performed in the circuit, represents energy as strictly deflected as when a cannon ball ricochets and the energy associated with it becomes dissipated in overcoming resistance at an angle to the original line of motion.

7. That magnetic polarisation is developed in the iron of the revolving armature to a considerable degree, as a consequence of the magnetic inertia and self induction of the armature convolutions, as well as the resistance encountered in the electric circuit itself and in the performance of work.

8. That the magnetic polarisation which does occur in the iron of the armature at one alternation is given out as current in succeeding one.

Reasons for believing that Lightning discharges and other electric currents travel somewhat faster through the centre of conductors than through their outer skins, as is commonly considered by mathematicians to be the case with rapid electric alternations.

An increase of the electrical pressure increases the rate of flow of electricity in a conductor. Connect a galvanic battery whose resistance is small enough to be negligible, through a given length of platina wire. Assume the difference of potential between the two poles = 10 volts and that the current developed by such electrical pressure is sufficient to burst up the platina wire, it will be surely admitted that the current which breaks down the molecules must have passed fairly through them. The writer himself is of opinion that under such circumstances the molecules are as completely broken down as when a wire is dissolved chemically, and that so soon as the energy associated with the current has been transformed into heat motion and dissipated, the atoms come together again, forming new molecules.

Close a galvanic battery of 20-volts pressure through a similar length of platina wire and deflagration will occur as before, but a 20-volt pressure will force electricity through the wire twice as fast as a 10-volt current, and therefore the work will be performed in half the time. Now the energy associated with dynamic electricity is as the square of the current, and although the duration of the current is only half as long, there will be in this shorter period twice the energy unlocked by the galvanic battery and transformed into heat motion, and consequently it is thought the wire should be burst up with twice the violence.

Now discharge a statically charged Leyden battery having a surface of, say, 100 square feet through a fine platina wire; if the battery be charged to a sufficiently high potential to burst up and deflagrate the wire, it will be found capable of bursting up a considerable length.

The statically accumulated electricity of a Leyden battery becomes dynamic electricity during the act of discharge, the only difference between a statical discharge and a galvanic current being, that the latter commences as a small current, rises rapidly to its maximum potential, and flows steadily at a fairly uniform rate through the circuit, whereas a Leyden jar discharge rises almost momentarily to its maximum potential and then falls, at first very rapidly, and gradually slower and still more slow, requiring theoretically infinite time to completely discharge.

At the commencement of a discharge, a Leyden battery behaves as a galvanic battery of infinitely small resistance and consequently it is capable of developing theoretically, during an infinitely small interval of time, through a circuit of infinitely low resistance, and infinitely small magnetic inertia, a current approaching to the infinitely great.

Regarding a statical discharge as a flow of electricity, the current that passes through a path of discharge is greater inversely as the time occupied in completing the discharge is less; and if it be assumed that the potential of the statical charge which is capable of deflagrating the fine platina wire = 20,000 volts, then the electrical pressure at the commencement of the discharge will be 2,000 times as great as that of a 10-volt current.

A 20,000-volt current has 4,000,000 times the energy of a 10-volt current; but what the average voltage of a discharge from a Leyden battery charged to a potential of 20,000 volts may be during its passage through a wire which it deflagrates, the writer is unable to say, but a few simple experiments would throw light on this point and enable a rough approximation to be probably arrived at. The famous experiments of Wheatstone went to show that a Leyden jar discharge through air occupied less than the one millionth of a second, and that a statical discharge through half a mile of wire under conditions favourable for the development of self-induction, occurred in a space of time of not more than the twenty-four thousandth part of a second.

The writer is of opinion that, assuming a 10-volt pressure to be capable of bursting up a given length of platina wire, the current developed by a statical discharge which does the same amount of work will not be greater than that of a 10-volt current, for the resistance conductors oppose is to the current or the quantity of electricity forced through in a given time, and if the electrical pressure exerted inside the molecules exceeds a certain definite amount, their structure is burst up much in the same way as happens when the pipes of a hydraulic system are subjected to an undue internal pressure.

The energy associated with a statical charge of high potential, such as that accumulated in Leyden batteries, is very large relatively to the quantity of electricity, and the transformation of this energy into heat motion when a conductor is deflagrated by electrical pressure, creates a path of discharge, apart from the conductor, through the envelope of highly heated air, and therefore the average current passing during the act of discharge may be greater than the bursting up quantity. In any case it cannot be less.

It has been stated above, that a few simple experiments would throw light on the average current developed by Leyden jar discharges. A rough approximation would be obtained, it is thought, by observing the length of wire a Leyden jar discharge of a given potential is capable of deflagrating, for example, if a 10-volt current developed by a galvanic battery is capable of deflagrating, say, one inch of platina wire, and the Leyden jar discharge deflagrates 10 inches, then the current which deflagrated 10 inches must have equalled at the very least 100 volts.

(*To be continued.*)

Lahmeyer Dynamos.—Messrs. Groeneveld, of Amsterdam, who own the Lahmeyer patents for France, are starting works in Paris for the manufacture of the Lahmeyer dynamos.

ELECTRIC LIGHTING AT THE UNIVERSAL EXHIBITION OF 1889.

(*Continued from page* 330.)

THE entire installation was complete on April 25th, 1889, and its working up to the close of the Exhibition left nothing to be desired. If I had to resolve anew the problem set by the syndicate for the Société Gramme I should not hesitate to make the installation in exactly the same way.

The *Station Edison*, situated on the Avenue de Labourdonnais, was designed and executed with the view to its purchase by the city after the close of the Exhibition, which has, in fact, been done. It represents a very successful type of a fixed central station. It is the only one now open to visitors, and I cannot too strongly advise those of you who have not yet done so to go and see it for yourselves. It is worth the trouble of a detailed examination.

A fixed station in a city like Paris ought to take up little space, consume a moderate amount of fuel, regard being had to the current produced, and be composed of elements the grouping of which admits of one of them being at rest without the service being brought to a standstill.

The restricted nature of the site calls for the employment of vertical engines, multitubular boilers, and of dynamos attached directly, or by simple belting, to the machine. Economy in fuel may be realised, by means of improved dynamos, of engines of very great expansion, or admitting of sudden closing, absence of prejudicial spaces, and boilers of great yielding capacity.

The distributing boards and the method of coupling the dynamos should admit of a dynamo, a machine, or a boiler being repaired without interrupting any portion of the lighting.

Every one of these conditions has been complied with at the Edison Station, Avenue Labourdonnais.

The boilers, three in number, belong to the Belleville system. Each is capable of 2,600 kg. steam at the rate of 10 kg. per hour. The feeding is done by two independent pumps.

There are five vertical steam engines, each of 150 H.P.; four of them are of triple expansion, the fifth being compound. Every one of them has been made by Weyher and Richemond.

Triple expansion engines being new, I will just point out their essential peculiarities.

They contain four—a small, a medium size, and two large—cylinders, arranged two and two in *tandem*, the small and medium-sized ones above, and the remaining two below. This arrangement allows of the reduction to two of the number of the shafts, piston rods, and equalises the strain upon each of them.

The steam, with a pressure of 10 kg., operates in the first cylinder during a half-stroke of the piston, then makes for the medium sized cylinder, where it continues to expand; and, lastly, it reaches the two large cylinders, where it completes its expansion before escaping into the condenser. The introduced volume is in the ratio of $\frac{1}{12}$th of the escaped volume. The cylinders' distribution at high and mean pressure is by means of equipoised cylindrical slide valves; the large cylinders have double orifice plane slide valves. Two eccentrics, fixed to the driving shaft, are sufficient to operate the four valves.

The cylinders are enclosed in a steam jacket and a thick casing of some non-heat conducting substance.

The driving shaft is in two pieces; it bears two rectangular cranks, and has four supports forming part of the framework.

The interior lubrication is done by means of an oleometer, the drops from which may be seen. All the joints, both fixed and movable, are lubricated with solid grease, by means of fixed apparatus, which are easily accessible while the machinery is in operation.

The main shaft, the two parts of which are united by a rigid plated socket, has a fly wheel at both extremities. One of these is furnished interiorly with a centrifugal governor, which operates a balanced valve placed at the mouth of the small cylinder, by means of a Denis compensator.

Upon leaving the large cylinders the steam from the four triple expansion engines makes its way into a condenser of unique pattern composed of a vertical injection receiver, which is fitted with a pulveriser by means of which the quantity of cold water may be reduced to 150 lit. per H.P. hour.

Two equipoised automatic air-pumps are employed for extracting the air and water from the condenser.

The condenser constitutes thus a special apparatus which admits of being placed at a tolerable distance from the engines. This is a capital arrangement, since it obviates noise, lessens the cumbrousness and the complexity of the engines, and enables the application to the pumps of their proper rate of speed at all times.

I am told by the makers that the consumption of steam by their triple expansion engines is not more than 6 kg., 5 per H.P. hour.

The electrical plant at this station comprises two No. 8 type 100,000 watts shunt dynamos and four No. 7 type 55,000 watts shunt dynamos; being, you observe, as regards number and power almost the same combination as that adopted by the Société Gramme for its dynamos.

Each of the two 100,000 watts dynamos is operated by a triple expansion engine. Each of the two other triple expansion engines operates two 55,000 watts dynamos.

For the private lighting service the company had installed two other 55,000 watts dynamos, the motive force being supplied by a 150 H.P. compound engine.

The following are the leading features of the large 100,000 watts dynamos:—

No. of ampères	800
„ of volts	125
Armature:—	
Linear velocity	10 m. 50
No. of revs. per minute	350
Exterior diameter...	0 m., 630
Length of generator	0 m., 800
No. of divisions of the collector...	40
Resistance	0·0054 ohm.
Weight of copper	190 kg.
Field Magnets:—	
Resistance	4·25 ohms.
Maximum exciting current ...	29·5 amps.
Weight of copper	285 kg.
Electric yield	96·5 per cent.

The distribution is by the three-conductor system with two dynamos coupled in series. The four circuits are joined in parallel.

Current reversers and field magnet rheostats, such as are usually employed in the Edison system of lighting, and a well managed distributing board complete the electrical portion of this station.

This installation, I repeat, represents a very successful type of fixed station intended to occupy a central position in a great city. It appears to me somewhat costly and complicated as regards the mechanical portion for the temporary demand upon the syndicate, but I am pleased to admit that from the constructor's standpoint it leaves nothing to be desired.

Station Jablochkoff.—We have just inspected two factories, one intended for a lighting of brief duration, and the other constructed for the purpose of continuous lighting, and each possessing the qualities requisite to the demands to be made upon them; one being characterised by its simplicity and reliability in operation, the other by economy of space and fuel. We are now going to examine a third type corresponding in all respects to the scheme comprised in the syndicate's original contract, *i.e.*, in exhibition station.

The Société l'Eclairage Electrique, which installed the station on the banks of the Seine, and which I have already referred to as the inventor of electric candles, did in fact aim at a regular exhibition of the dynamos manufactured by it. It even extended its hospitality to a Ferranti machine, and thus afforded an opportunity for a close study of the system which appears to have secured the preference in large English installations.

We are not now dealing with six or eight dynamos having a mean power of 100 h. each, but of twenty-three dynamos, *i.e.*, 19 generators and 4 exciters, thus :

6 continuous current Rechniewski dynamos, 16,000 watts each.
4 „ „ „ „ 26,000 „ „
4 alternating current Gramme dynamos of 32 Jablochkoff candles each.
4 alternating current Gramme dynamos of 20 Jablochkoff candles each.
1 alternating current Ferranti dynamo of 12,000 watts.

We are acquainted with these three systems of dynamos, and, therefore, need not describe them. I will only remark that, thanks to this competition, the Society *l'Eclairage Electrique* was able to show us:

1. Electric lighting with continuous and alternating currents.
2. „ „ with high, mean and low tension.
3. „ „ with Jablochkoff candles, with regulators and incandescence.
4. Arc and incandescent lamps with continuous current and alternating currents.
5. Electric lighting direct and with transformers.
6. Lighting systems for great and short distances.

For the first time, Jablochkoff candles were mounted in series of 16 upon the same circuit, and operated by means of transformers.

It was all very interesting, but, it must be confessed, a trifle complicated for a public and a private service which were essentially temporary.

As the Rechniewski dynamos were the most novel of those employed by the *Société l'Eclairage Electrique*, I will now place before you some details as regards their weight, their speed and the specific power.

	Dynamos (16,000 watts).	Dynamos (26,000 watts).
Weight	187 kg. ...	980 kg.
Angular speed, per min. ...	2,000 revs. ...	800 revs.
Periphery speed, armature...	12 m. 2 ...	11 m.
„ „ pulley ...	14 m. ...	12 m. 48
Watts per kilog. of copper, armature	823 ...	800
Watts per kilog. of copper, total...	274	225

The firm of Leconteux and Garnier were entrusted by the society with the installation of the motive power and of the boilers necessary to operate the dynamos.

MM. Leconteux and Garnier installed, to begin with, three Terme and Deharbe boilers, each capable of producing 2,000 kg. steam per hour ; next, owing to delays in the completion of these generators, they placed two further boilers on the Roser system, each capable of producing 2,500 kg. steam per hour. Thus the Station Jablochkoff had at its disposal, after the completion of the five boilers, 11,000 kgs. steam per hour.

The motors were comprised in two distinct groups ; the first of these groups was composed of two Corliss horizontal engines of 170 H.P. each, making 180 revolutions, and having four slide-valves and Leconteux and Garnier regulator system and condenser immediately attached. The second was composed of two engines, likewise horizontal, of 150 H.P. each, making 250 revolutions the minute, and having the condenser directly attached as in the first group. These two engines had but one equipoised slide-valve.

They could operate simultaneously by means of a transmission with a clutch in the centre. They could operate together upon the entire shaft, separately upon each half of the shaft ; one of them might, if need be, drive the whole shaft and all the dynamos attached.

The *Station Marcel Deprez* was established in the *Jardin d'isolement* by the *Société anonymé pour le transmission de la force par l'électricité*, and was planned, as regards the installation, upon the principle of the Station Gramme—viz., horizontal engine, a small number of dynamos, &c. It differed from the latter, however, in its system of boilers, those in the Station Gramme being of great water capacity, and also in the addition of an intermediary transmission.

The boilers were of the Roser type. Four were set up, each capable of producing some 2,000 kg. of steam per hour ; but only two were actually lighted.

A fine Corliss engine, made by Leconteux and Garnier, supplied the movement to the transmission, to which all the dynamos were attached.

This, with a normal force of 500 H., made 60 revolutions per minute. The condenser had been placed under ground laterally in order to lessen the total length of the motor.

This motor had a double frame, and two cylinders was formed of two machines in couple, capable, if necessary, of being worked separately. Their fly-wheels were 6 m. in diameter, 0 m. 750 in width of tyre, and weighed 15 tons each.

I present you with these details in order to show you that we are not now dealing with a mere show machine. This engine forms part, in fact, of a large central station for the transmission of force by electricity, which the Society is erecting at Saint-Ouen. She did remarkably well throughout in connection with the lighting of the Champs-de-Mars.

The electrical plant is chiefly composed of four Marcel-Deprez double-ring dynamos, three being low tension and one high. The following table gives their principal features :—

High Tension Dynamo.

Difference in potential at the terminals	600 volts
Ampères (50 each ring)	100
Effective power	60,000 watts
Angular velocity	625 revs.
Intensity of excitement	25 amps.
Electric yield	95 per cent.
Industrial yield	90 per cent.

Low Tension Dynamo.

Difference in potential at the terminals (according to the coupling of the rings) during lighting ...	75 or 150 volts
Difference in potential at the terminals depending upon the accumulators	160 volts
Ampères	500
Angular velocity	625 revs.
Intensity of excitement	12 amps. per 115
Electric yield	96 per cent. for 115 volts
Industrial yield	92 „ „ „ „ „

Each ring was worked by special belting, and admitted of being revolved independently of the other on the same dynamo. Actually the station possessed two high tension dynamos and six low.

The currents of the former supplied the regulators, which were arranged 12 in series and 5 in parallel. The low tension currents were capable of directly feeding the arcs in parallel or of charging the accumulators.

The station possessed two batteries of Julien accumulators, each composed of 65 elements of 160 kg. The 130 elements had a total capacity of 280,000 ampère-hours, corresponding to 10 ampère-hours per kilogramme of plates. So, when fully charged, the batteries comprehended some 500 H.P. hours.

Apart from a trifling hitch or two to begin with, this station realised very well the demands made upon it.

The *Station Ducommun* was installed by MM. Steinlen & Cie. in the *Cour de la Force Motrice*, and was of 30 H.P. nominal. Owing to exceptional circumstances it only furnished some two-thirds of its total power.

The steam came from two multitubular boilers of Messrs. Daydé & Pillé's construction, which were placed in the court some distance from the station.

The motor for the machinery comprised three steam engines of the American type, called "Straight line," each of 100 H.P.

These were one-cylinder engines, were non-condensing, and had two flywheels side by side in the interior of the frame. One of these enclosed a centrifugal governor. Two pullies 1 m. 50 in diameter were placed exterior to and at either side of the frame to work the intermediary transmission. The speed wsa 200 revolutions per minute.

The transmission was formed of two parallel shafts in three attached pieces, simultaneously operated upon by three steam engines, thus admitting of the isolation whether of one of the engines or of one of the shafts, or of a certain number of the dynamos.

The electrical plant comprehended twenty-two Gramme dynamos, thus :—

5 of 8 ampères and 1,000 volts, making 620 revs. per min.
7 of 8 „ „ 750 „ „ 675 „ „
1 of 10 „ „ 500 „ „ 650 „ „
5 of 25 „ „ 250 „ „ 650 „ „
4 of 110 „ „ 110 „ „ 520 „ „

I need not say how well the carrying out of the work assigned to this company was looked after in every particular. The firm of Ducommun has the reputation of being one of the best in the world for the excellence of its mechanical arrangements.

Station du Syndicate.—Properly speaking, there was none, the syndicate having merely caused two sites to be roofed in and enclosed. One of these was situated close to the Palais des Machines, between the stations Gramme and Marcel Deprez; the other was upon the embankment of the Seine, and was used for storing machinery belonging to members, and for the establishment of boilers and of gas motors which were necessary.

The station situated near to the Palais des Machines contained installations by Messrs. Garnot and Borssat, of the Société des Forges et Chantiers de la Mediterranée, and of the Société Française de Matériel Agricole de Vierzon. It also contained a Naeyer boiler, productive of 2,400 kg. steam per hour, a Pressard boiler of 700 kg. capacity, a Lacroix ditto of 800 kg., a Terme and Deharbe ditto of 800 kg., a Roser ditto of 1,100 kg., one of Durenne of 1,300 kg., one of Archambault of 700 kg., and a Montupet ditto of 800 kg.; the total evaporation of these eight generators was 8,800 kg. the hour, equal to a force of about 800-horse.

M. Garnot had installed a steam turbine on Parson's system, making 12,000 revolutions per minute, and operating directly upon a dynamo of 100 ampères and 70 volts.

M. Borssat had installed a steam engine, having two equal and independent cylinders of 100 horse-power nominal. This machine, by means of a subterranean transmission, operated two Gramme dynamos of M. Borssat's construction.

One of these dynamos, with a speed of 800 revolutions per minute, produced a current of 10 ampères and 1,500 volts; the other, with a speed of 850 revolutions, produced a current of 25 ampères and 600 volts.

The Société des Forges et Chantiers de la Mediterranée had placed a high speed engine at our disposal; this directly operated a 4-poles dynamo, under the supervision of Captain Krebs.

The compound engine system worked with 10 kg. steam, making 350 revolutions per minute. Its cylinders had, respectively, 0 m., 320 and 0 m., 216 diameter, the piston's stroke was 0 m., 260.

The dynamo produced a current of 250 ampères and 110 volts, and an industrial yield of 84 per cent; the steam engine developed an effective 43 horse-power.

The Société Française de Materiél Agricole de Vierzon had installed a horizontal steam engine, on the compound system, with an intermediary reservoir fitted with a Meyer small cylinder expansion gear, and with expansion gear attached to the large cylinder. This engine, which was of 35 horse-power and made 130 revolutions per minute, operated a superior type Gramme machine of 170 ampères and 70 volts.

In the Embankment Station the syndicate had placed two 24 horse-power gas motors and one of 16 horse-power, a battery of 60 Julien accumulators, two Pieper dynamos and one superior type Gramme ditto.

The Pieper dynamos made 700 revolutions the minute, and together produced 125 ampères and 250 volts. The Gramme dynamo made 1,300 revolutions per minute, and produced 60 ampères and 140 volts.

Postes d'Electricité at the *Palais des Machines*. These were eight in number and thus distributed :—

Class 50.—MM. Sautter, Lemonnier et Cie., installation.
„ 52.—MM. Jasper and Dulait, installation.
„ 53.—La Compagnie Electrique, installation.
„ 57.—M. Fabius Hernion, installation.
„ 62.—Messrs. Mildé and Gerard, installation.
„ 63.—Messrs. Latimer Clark, Muirhead & Co., installation.
English Section.—Messrs. Crompton & Co., installation.
Swiss Section.—MM. Alioth et Cie and des Ateliers d'Œrlikon, installation.

M. Popp, who was one of the syndicate, had his dynamo in his own exhibtion, class 62.

Messrs. Sautter, Lemonnier et Cie, had in operation one of their vertical compound engines for use in navigation. The following are some particulars as regards this.

Diameter of the large cylinder	0 m. 520
„ „ small „	0 m. 350
Piston stroke	0 m. 240
Number of revolutions per minute	275
Steam pressure	6 kg.
Horse-power	120

This operated on an 8 pole compound dynamo excited *in shunt*, and producing with 275 revolutions, 1,000 ampères, under 70 volts of potential difference. The eight bars of electro-magnets formed a kind of enclosure for the bobbin. This was a Gramme and had an exterior diameter of about 1 m. and a length of 0m. 50.

M. Jasper's installation consisted of two Gramme dynamos of his own make, having their electro-magnets with consequent poles arranged vertically. These dynamos each furnished with 1,050 revolutions per minute, 100 ampères under 125 volts.

M. Dulait's installation was a compound 4-pole dynamo with redressed currents and ring armature, and a total power of 50 h. Normally it produced 175 ampères under 110 volts. Its speed was 420 revolutions per minute.

The Jasper and Dulait dynamos were worked by "Otto" gas motors, kindly placed at the syndicate's disposal by the Society which holds the French patent, and which made a very noteworthy exhibition in class 52.

One of this society's gas motors likewise drove the dynamos of the electric company. These were four in number and were driven by friction, like those which were used for my experiments in long distance transmissions in 1886, and each had a capacity of 8 ampères under 1,100 volts with a speed of 1,000 revolutions per minute. Two of these dynamos insured the service, the third, whose force was reduced by lifting off the brushes, excited the field magnets of the two first. The fourth was held in reserve.

Extremely ingenious hydraulic disconnecting gear enabled each dynamo to be instantaneously set going or stopped.

M. Fabius Henrion had installed a Schuckert dynamo with ring armature, of his own make, producing, with 680 revolutions the minute, 125 ampères at 110 volts. This dynamo was worked by a 24 H.P. gas motor lent to the syndicate by the *Compagnie Parisienne.*

M. Mildé, on behalf of the *Syndicat des brevets Clerc*, had installed an alternating current dynamo, producing 10 ampères at 3,200 volts, and excited by a current of 30 ampères at 110 volts, with a speed of 540 revolutions per minute.

The two latter dynamos were driven by a compound engine of 100 H.P. made by J. Boulet et Cie.

(*To be continued.*)

CUTTRISS'S PATENT CALCULATING DISC.

THIS is a very neat little instrument suitable to be carried in the pocket, it is an improved form of slide rule by which a great variety of mathematical calculations can be performed with rapidity and certainty. The instrument consists of a thin metal disc round the circumference of which slides a ring of corresponding thickness, both the disc and ring having scales engraved upon them, as shown in figs. 1 and 2. Two scales are engraved on the disc and two on the ring, which are marked A, B, C, D, in the illustration. The scales, A, B, C, are each divided into nine unequal parts, numbered consecutively, from 1 to 9. They may also represent any multiple or sub-multiple of these numbers, as 10, 20, 30, &c., 100, 200, 300. &c., or 0·1, 0·2, 0·3, &c. The scale, D, is divided into 90 unequal parts, numbered consecutively, from 1 to 90. All the scales are divided, as far as convenient, in manufacture. By placing the scales in definite relative positions with each other, calculations can be readily performed involving multiplication, division, proportion, vulgar and decimal fractions, powers, roots, and a large variety of problems, and, of course, resistances, weights, &c., of wires. It is made solely by Messrs. Elliott Brothers, London.

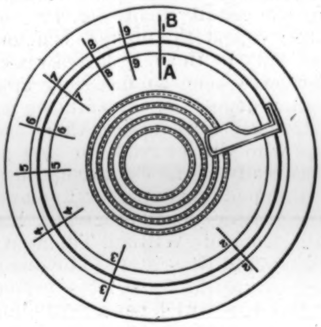


FIG. 1.

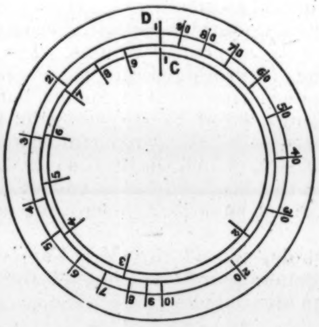


FIG. 2.

EDINBURGH ELECTRICAL EXHIBITION.

THE scheme for lighting the buildings at the Edinburgh Exhibition is an elaborate one. Electricians are engaged throughout the whole establishment fixing up the wires, and the arrangements, as well as the general supervision of the machinery section, is under the charge of Mr. Wm. A. Bryson. The whole scheme of arc lamps will involve the use of considerably over twenty miles of wire. The dynamo court measures 120 by 80 feet in the centre of the machinery hall. The Brush Electrical Engineering Corporation have contracted to light the buildings and grounds by means of 351 arc lamps, each of 2,000 candle-power nominal. The current required for this will be generated by thirteen dynamos of the old Brush type, each capable of running 35 lamps, and two of 15 lamps each, which will be used for "pilot" or police circuits. Messrs. King, Brown & Co., of Edinburgh, will introduce a special installation for the concert hall, which it should be noted is a large and high-roofed building containing a spacious orchestra. This room will be beautifully illuminated by 110 Sunbeam lamps, each of 200 candle-power nominal. The current for this scheme is to be generated by four powerful dynamos of Messrs. King, Brown and Co.'s own manufacture. The motive power for all this installation is to be supplied by two firms, Messrs. Robey & Co., of Lincoln, and Messrs. Alley and McLellan, of Polmadie, Glasgow. Messrs. Robey send one 80 horse-power nominal engine with triple expansion gear, one 65 horse-power horizontal compound engine, one pair of vertical engines, one single vertical engine, and one high-speed horizontal compound engine; and all these will be used for the purpose of driving the Brush machines. Messrs. King, Brown & Co. will supply two Westinghouse engines from Messrs. Alley and McLellan, of 100 and 125 horse-power, respectively. Besides these arrangements, numerous private firms will contribute to the illumination of the stalls and courts; while, besides, it will be arranged that certain portions of the grounds will be prettily decorated with coloured electric lamps.

ELECTRIC LIGHTING IN THE CITY.

LAST Tuesday a special meeting of the City Commission of Sewers was held at the Guildhall, Mr. Frank Green presiding. The Streets Committee reported that they had again had under consideration the draft of the proposed contract with the Brush Electrical Engineering Corporation, as returned by their solicitors, with various proposed alterations, and while deeming it necessary to resist certain of those alterations, they recommended the Court to concur in the following, namely :—(1) That the company have way-leave in subways for private supply, notwithstanding the contract for public supply might have been determined; (2) That the private supply be exclusive for 21 years, whether the contract for public supply be determined or not; (3) That, as regarded the remedy of defects found on inspection, the penalty should not be enforced if the work of repair were commenced within 24 hours and were proceeded with diligently to the satisfaction of the engineers; (4) That, as regarded the sliding scale, 7½ per cent. per annum on the capital sunk in the plant and machinery should be allowed for depreciation, and 5 per cent. of the profits available for dividend for a reserve fund, until such fund should amount to a quarter of the paid-up capital; (5) That though the purchase of the undertaking for public supply at 21 years was under the Act, the purchase of the private supply at 21 years should be by agreement or arbitration; the purchase of either at 42 years to be under the terms of the Act. In the event of the Court's concurring in those recommendations, the Committee asked authority also to conclude similar terms with the Laing, Wharton and Down Construction Syndicate for another district. Mr. Cloudsley moved the adoption of the report. Mr. J. E. Sly proposed that it should be referred back for consideration, as he objected to the companies having the right to supply private consumers, if their contract for the public lighting of the district had been terminated. The companies seemed to be imposing their own terms on the Court. Mr. Bowring thought it would be a public scandal to hand over the City, bound hand and foot, to private companies for 21 years. It would appear to be a premium to the companies tempting them to break the public lighting contract as soon as possible, having secured a monopoly of the private supply for so long a period. The chairman pointed out that the Act prevented them from giving an exclusive right to a company to supply the electric light within a given area, and the Commission were only contracting so far as they were able. Mr. C. T. Harris said that the proposed alterations were all adverse to the ratepayers, and should not be entertained. Mr. W. H. Pannell, on the other hand, thought the Commission were making infinitely better terms than they would obtain under a provisional order. None of the alterations, in his opinion, was inimical to the ratepayers' interests. Mr. Deputy Scott and Mr. George Shaw also supported the report. The amendment was negatived by a considerable majority, and after some further discussion the report was adopted.

REVIEWS.

Electric Transmission of Energy and its Transformation, Subdivision and Distribution. By GISBERT KAPP. London: Whittaker & Co.

The first edition of this excellent work has, we believe, been out of print many months, and we have been looking forward to the second. Electrical literature ages very quickly, and the progress in the domain of the subject under discussion has been astounding. The principles laid down by Mr. Kapp more than three years ago suffered, however, very little change; indeed he had the pleasure of seeing them developed and generally adopted. The author himself admitted, in his summary of recent additions, that although he had made use of his own method of treating the theoretical part of the subject when the first edition was published, yet he did not then feel sufficiently confident of its general applicability. Since then, experience has demonstrated the accuracy of Mr. Kapp's reasoning; it has been adopted by many engineers, and he is expanding his favourite part in accordance with the progress made within the last three years; and this part, as our readers may guess, comprises the construction of dynamos and the predetermination of their characteristics. Whilst we fully appreciate these improvements, we cannot help thinking that the author has somewhat neglected to write up to date what he primarily professes; virtually the electric transmission of energy begins at the terminals of the dynamo, and it ends at the motor shaft.

It cannot be expected that in a book of such modest dimensions one should find all the mechanical details of electric cranes, tramcars, lifts, and the like, but we hoped to have seen some account of recent developments in electric traction, a discussion of the conditions of electrical circuits, where the length, resistance and applied energy is continually varying, and where leakage, especially with underground conductors, plays an important part. A thorough knowledge of the production of electric currents and of efficient apparatus, therefore, is certainly necessary; but we must allow that the book before us is not supposed to be a treatise on dynamo machines, and on this ground we venture slightly to differ with the author's good intentions.

On the appearance of the first edition we devoted several columns to reviewing this thoroughly practical and useful book, and we can only repeat the praise we then expressed with regard to various chapters, which were so well written that they required very little alteration. The last chapter in the present edition is new, and it contains descriptions of some of the best examples of installations put up for the purpose of transmitting electric energy. Mr. Kapp found some obstacles in choosing examples; "As the present book," he notes, "is primarily intended for English readers, the author might naturally be expected to select for detailed description work carried out by English firms. But here arises some difficulty. In the first place, although a considerable amount of work of this kind has been carried out by English firms, the magnitude of each individual plant is far below the average of Continental or American installations, a fact primarily due to the scarcity of water power and the abundance of cheap fuel in England." This we admit, although we still adhere to a statement made several years ago, which was to the effect that, in numerous instances, the kinetic energy in the thousands of tons of rubbish at many pits' mouths, which is scarcely worth shovelling upon carts, may be profitably transformed and transmitted electrically to industrial centres twenty or thirty miles distant. "In the second place," says Mr. Kapp, "English makers have hitherto not considered it necessary or expedient to submit the work carried out to the test of independent authorities, and in recording the results achieved, the author would have to simply repeat the maker's statements." This, we opine, can only be the very last of reasons why electricity has hitherto been so meagrely applied in this country for the purposes of transmitting power to distances. If the necessity arises, there are plenty of English firms who will be ready to carry out the work, and equally as ready as the Continental firms to submit their work to independent experts, who may or may not be credited with a greater capacity for truth. Have not many of our experts, from Sir William Thomson downwards, figured from time to time in the glowing prospectuses of promising companies? Let the capitalist go to a good substantial firm which has a reputation to lose, and let him draw a dividend out of the working of an installation; this will inspire far more confidence than the figures of a hundred experts, and his example will be followed quickly enough.

Power transmission by means of alternating currents finds no place in the present volume. The author does not deny the future possibility and probable convenience of alternating current motors, but up to the present he cannot point to one successful installation. What have become of the wonderful motors of Tesla and Zipernowsky, which have been brought to our notice within the last two years, and of which their advocates claimed superiority over continuous current motors?

On the whole, we admire Mr. Kapp's style and method in general, and recommend this "practical handbook" to all students of electrical science.

Electrical Engineering for Electric Light Artizans and Students. By W. SLINGO and A. BROOKER. London: Longmans, Green and Co.

(Concluded from page 323.)

In the first seven chapters some of the principal laws of electric currents are dealt with; these appropriately lead up to Chapter VIII., in which alternate current dynamos are considered. The writers start with the consideration of the simplest type of dynamo, pointing out its weak points, and then trace the development into a practical and highly efficient machine. The *sine* law is here very lucidly explained, just in such a manner, in fact, as directly appeals to the student. Mr. Mordey's model, showing the method of applying the excitation principle, as used in the transmitter of the Wheatstone A B C instrument, we notice, is described. We next have the De Meriten's machine illustrated; and then, that of Mr. Kapp, which, as the authors point out, seems to follow as a natural evolution of the De Meriten's machine. Various types of alternators carry on the chapter to its conclusion, many interesting details being explained. Further we have direct current machines discussed with great clearness, the illustrations being sufficiently numerous to make everything plain to the student. The drawings explaining the various methods of winding dynamos, though explanatory enough when carefully looked into, are, perhaps, hardly as artistic or as plain as they might be; something more in the style of the diagrams in Prof. Sylvanus Thompson's book would, we think, be preferable. In Chapter X. we have illustrations of some of the best modern direct current dynamos, only those of first-class design and construction being considered. The Statter dynamo particularly comes in for a large share of notice. In the chapter we have just referred to, dynamos in which all the coils are connected together, that is closed circuit dynamos, are those explained; in the succeeding chapter open circuit machines are described, the Brush and the Thomson-Houston coming under this head. In referring to electric motors, the principal system of electro traction noticed is that of Mr. Holroyd Smith, at Blackpool, the lines in America not coming in for observation.

Transformers are dealt with at some length, it is here pointed out that C. F. Varley, over 30 years ago, patented a pattern of transformer which, in many respects, is similar to those used at the present day.

Secondary cells come in for a fair share of attention, the important points in the same being briefly but sufficiently described.

Of the remaining chapters, the contents of which we mentioned in our last issue, we need not particularly allude to; it is sufficient to say that they all show a most judicious selection of material; in fact, this is a characteristic of the book.

In conclusion, we would say that whilst we have but little to criticise, we have a vast deal to speak of in highly favourable terms. Messrs. Slingo and Brooker have, we think, scored a decided success, and written a book of which they may be proud, and which will be of great value to those for whom it is written.

NOTES.

Electric Lighting in Paddington.—Last Friday a special meeting of the Paddington Vestry was held at the vestry hall, Paddington Green, for the purpose of considering the question of the electric lighting in the parish, which had been considered by a committee of the vestry. Colonel H. C. Barchard proposed the adoption of the report, which recommended that the application of the Kensington and Knightsbridge Electric Lighting Company should be assented to. But if the vestry considered the draft regulations now being prepared by the Board of Trade to do away with the objections to the high pressure supply system, then the committee considered that the application of the Metropolitan Company might be considered. Both the Kensington and Knightsbridge Company and the Metropolitan Company object to the insertion of any clause reducing the time for purchase below 42 years. As the cost of lighting the streets with electricity would be very greatly in excess of gas, the committee did not feel justified in recommending it, though in the future, when the electric company's arrangements had been more matured, action could be taken for so doing with advantage. He observed that since the report had been drawn up, the Metropolitan Company had varied its list of prices, and probably the other company would desire to vary its scale of prices, and he should propose that the company be communicated with, with that object in view. Colonel Blair strongly objected to this. The Metropolitan Company was merely trying to gammon the vestry, and he was in favour of the recommendation of the committee being adopted. Mr. Stephenson said he should second the proposition of Colonel Barchard. Mr. H. H. Mills proposed, as an amendment, that the provisional order be amended, inasmuch as the draft provisional order prepared by the committee did not secure to the ratepayers such advantages as they were entitled to receive as a consideration for the very valuable concession involved in the granting its assistance to a company to obtain an order for lighting the parish. Mr. T. S. Anderson seconded the amendment. Mr. Mark H. Judge opposed both the propositions before the vestry. The report was not a trustworthy document, and he was in favour of adjourning the matter. It was agreed to adjourn the further consideration of the matter.

Lighting a Brewery by Electricity.—Thanks to the enterprise of Mr. William Smith, the proprietor, the large brewery at Bramley, Surrey, is now lighted entirely by electricity. The installation, which has been furnished by Messrs. F. C. Allsop & Co., of 165, Queen Victoria Street, London, comprises a shunt wound dynamo, with an output of 20 ampères at 70 volts when running at the speed of 2,000 revolutions per minute. The same engine which drives the brewing machine is utilised for the dynamo, which stores up the electricity in twenty-eight accumulators, capable, when fully charged, of lighting twenty lamps for ten hours. The interior of the brewery is illuminated by fifteen 20-C.P. incandescent lamps, while a 40-C.P. lamp is employed outside to light the entrances. Twelve 20-C.P. and one 40-C.P. lamps are distributed among the offices, front shop, and dwelling house, and the lamps in the offices are fitted on adjustable pendants, which permit of their being raised or lowered, as occasion my require. The switch board is located in the engine house.

The Electric Light at Brighton.—At the last meeting of the Brighton Town Council, the common seal of the borough was ordered to be affixed to documents relating to the property lately acquired for electric lighting purposes.

China Receives the Light.—The new Viceroy of China, Li Hun-Chang, has issued a proclamation intended to smooth the way for the company which is introducing the electric light into the "flowery land." One of the advantages which his Excellency lays stress on is the comparative immunity from accidental fires it will secure.

Electric Lighting at Rotterdam.—It is said the communal authorities at Rotterdam are studying the question of lighting the city by electricity. Different systems are being tested. Companies are already at work, but all under immediately terminable contracts.

The Electric Light in Madrid.—The Electrical Supply Company of Spain have advertised that they are ready to supply electricity for light and power in Madrid. Their circular announces that their charge for electric lighting is one halfpenny per lamp-hour of 10 candles, and 1s. 4d. per 1,000 watt-hours. It is probable that these prices will be reduced in view of the competition which is expected.

Electric Meters.—The report of the commission appointed to decide upon the merits of the instruments submitted to competition in Paris has been published, and we reproduce it on page 357. Amongst the signatories to the report we notice the names of MM. Hospitalier, Carpentier, Mascart, Potier, and other well known scientists. We trust that some of our own inventors may be induced to enter for the next competition, for we believe we could name one meter which would stand a good chance of carrying off the first prize.

The Electro-Harmonic Society.—We much regret that Dr. Hopkinson will be unable to occupy the chair to-night, which our readers are aware he promised to do conditionally only. Mr. Crompton, however, with his usual good nature, has kindly consented to preside, and we anticipate an extra large audience at this, the last concert of the season.

He no Longer Smiles.—Bailey Roeth, proprietor of the Union Telegraph Company, St. Louis, U.S.A., obtained about $10,000 in the past six months from gullible students at $40 a head. He stipulated that all graduates would receive situations worth $100 a month. When graduates demanded situations, Roeth, says an American contemporary, would smile and say he had a nice place in South America, Mexico, or Siberia, which a man or woman about the size of the applicant could fill. Roeth has since been arrested for fraud.

Electrical Traction Tramways.—At the West Metropolitan Tramways Company's half-yearly meeting at the Cannon Street Hotel, on Friday last, the chairman, Mr. E. H. Bayley, in moving the adoption of the report, spoke of the proposed reconstruction of the Acton line of the company, and of the negotiations which the directors had been carrying on for the working of that line by electricity. He said it was desirable to see the practicability of electrical traction for tramways, and he believed that, if carried out as they hoped, it would be one of the best paying lines in the country. Mr. Webb, the solicitor, said that the future of the company greatly depended upon their being able to raise capital for the reconstruction of the Acton line, and upon their being able to make satisfactory arrangements for electrical traction. It was well known that by that motive power they would be able to effect a great saving, as electrical traction was nothing like so expensive as horse traction. That saving would materially alter the position of the line, and the shareholders were justified in looking forward hopefully to the future, as the negotiations for the electrical working of the line were being carried on with one of the most powerful combinations in connection with such matters, and that combination had promised that the West Metropolitan Tramways Company would be the first that they would take up. The question had been asked whether the company had identified themselves with any special system of electricity, and he should tell them that they had not done so and that no special system would be adopted by the company which had not, in the opinion of the directors, proved a success before being introduced on their line. The arrangements which were now being negotiated contemplated no great outlay by the tramway company; but the traction company would be required to furnish plant and rolling stock, so that if by any chance the result turned out unsatisfactory the loss would fall upon the traction company, and not upon the tramways.

New Electric Launch.—A second electric launch has been built for Mr. Pears by W. S. Sargeant & Co., Chiswick. The boat has a mean draft of 18 inches, with a displacement of 2¼ tons. The hull is carved, and built of bright mahogany in narrow widths. Dead wood aft has been entirely abandoned, with the object of obtaining greater efficiency from the propeller, facilitating steering, and reducing surface friction to a minimum. The boat is steered by a tiller, and the switch, controlling the electric power, is flush with the after-deck, and within control of the steersman. Lead-lined compartments are arranged under the seats to receive 40 accumulators, supplied by the Electric Construction Corporation, which are computed to hold sufficient electrical energy with one charge to propel the boat for about eight hours at eight miles per hour. The motor is fixed under a centre compartment in the boat, and is calculated to develop 3 B.H.P. at 700 revolutions per minute.

Work in Newcastle.—The Newcastle and District Company has now between 50 and 60 installations at work on four circuits, one of which runs 1½ miles from the central supply station. An order has been received from the Corporation of Newcastle to light up some of the most prominent parts of the city.

Maxim-Weston Electric Company.—A shareholder writing to the *Financial News* says:—"The end of March is near, and shareholders in this company are still without any notice of the promised meeting or of the directors' report and balance-sheet. The answer to enquires made at the office for months past is that a meeting would be held very soon, but it appears that unless shareholders take some decisive step the meeting will be postponed for a long time yet. In the meantime no information is forthcoming as to the business done by the company, nor of the balance of working capital in hand. This unaccountable delay is most annoying to all shareholders, who like to know what is being done with their money."

A Presentation.—Mr. Dell, the late secretary of the E. P. S. Co., received from his late colleagues, last week, a testimonial in the shape of a purse of money, a timepiece, and an illuminated address.

Contracts.—Messrs. H. F. Joel & Co. have just obtained orders for the erection of two electric light installations, in which the generating machinery will be supplied by the firm in addition to their doing the wiring.

New Cut-Out.—Messrs. B. Verity & Sons are introducing a new cut-out in which the liability of inserting, by mistake, a fuse to carry more than the normal current is avoided. The same firm is also bringing out a new switch.

The Phonograph in Holland.—A company is being formed by electrical engineers in Amsterdam for the purpose of working Edison's phonograph patents. The promoters propose to reduce the price so as to bring the phonograph within the purchasing powers of all exchanges. Representatives will be appointed in the provinces to attend to the repairs of hired and sold phonographs.

The Royal Society.—Yesterday a paper was read by Prof. J. J. Thomson and G. F. C. Searle, on a determination of "*v*," the Ratio of the Electro-magnet Unit of Electricity to the Electrostatic Unit.

The Use of the Telephone.—The Stockholm General Telephone Company has introduced a new arrangement for the benefit of subscribers. The telephone company will receive per telephone, telegraphic messages from subscribers, which messages are then transmitted to the telegraph offices free of charge. A small deposit is required as a guarantee for the telegram fees. The telephone company also receives telegrams which have to be forwarded to subscribers in such cases where these live outside the area compassed by the messengers of the telegraph offices.

Land Lines and Lightning.—The *Journal Télégraphique*, of Berne, gives a table showing the various accidents which occurred to telegraph lines during the year 1888. From this list we take the casualties due to lightning in the undermentioned countries.

	Percentage of Casualties to		
Countries.	Posts.	Insulators.	Instruments.
Belgium	0·071	0·004	0·315
Denmark	0·035	0·009	1·491
France	0·070	0·019	0·675
Germany	0·055	0·001	1·613
Holland	0·071	0·011	1·851
Italy	0·220	0·042	2·222
Switzerland	0·035	0·005	3·030

It will be noticed that lightning damaged the greatest number of posts and insulators in Italy, and by far the greatest number of instruments in Switzerland. The least damage was caused to posts in Denmark and Switzerland, to insulators in Germany, and to instruments in Belgium.

Rise in Rubber.—A meeting has been lately held in New York by representatives of rubber goods manufacturers, for the purpose of discussing the condition of the rubber trade, and to decide upon what advance should be made in the price of rubber goods in consequence of the rise in price of crude rubber from 62 cents per pound last autumn to the present market quotation of 78 cents per pound. It was determined to make an average advance of 20 per cent. on the existing price of rubber goods. We understand that since this meeting the price of crude rubber has still further advanced, being now at from 80 to 82 cents per pound.

Easter Holidays.—We shall be glad to receive any communications intended for the REVIEW by an early post, as we go to press a day earlier next week.

Another International Conference.—Her Majesty's Government has accepted an invitation to take part in the International Conference, to be held in Madrid, to consider various industrial questions, more especially that of property in patents.

The Agricultural Hall Exhibition.—In addition to the exhibits mentioned in our last issue, the Acme Electric Works show several instruments, switches, &c. Messrs. Dan Rylands, Limited, of Barnsley, and 62, King William Street, London, have on view various samples of their glass-lined metal piping. It consists internally of a distinct solid glass tube covered and protected externally by ordinary iron tubing. Between the glass and the iron a suitable cement is inserted, and this makes the whole homogeneous, and also renders the piping unbreakable by ordinary use. The makers state that the pipes can be easily laid without soldering, as each pipe carries a union nut by which the lengths are easily screwed up, and a thin washer of gutta-percha or other suitable packing is interposed to obtain a perfectly sealed joint. Messrs. Rylands further claim that these pipes will successfully resist the action of frost, and also the most extreme changes of heat and cold. The glass-lined pipes are particularly adapted for electric lighting purposes, as the solid glass tube forms an excellent insulating medium, whilst the outside iron pipe affords protection both to the wires and glass. The makers state that several miles of this piping are already in use, and that it has given great satisfaction.

Exhibition.—The International Exhibition, which is to be held in July next at the Palais de l'Industrie, Paris, promises to be interesting as regards the electrical exhibits, and some new applications will be shown.

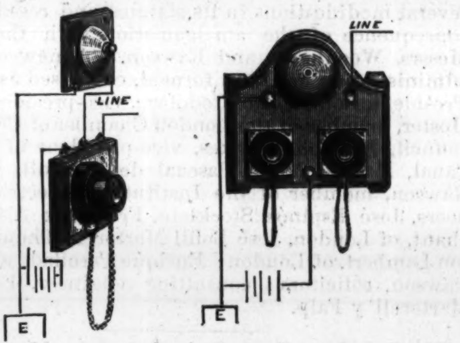
Atmospheric Electricity.—We learn from Kuhlow's that for a number of years exhaustive information on electricity in storms, with special regard to the influence of atmospheric electricity on the telegraph service and on telegraph apparatus, has been collected by the Imperial Telegraph Department, Berlin. At present, nine hundred telegraph offices have instructions to keep a record of the course, duration, direction, &c., of storms. From the observations made it appears that, while not altogether free from the influence of atmospheric electricity, such influence is materially smaller in the case of underground wires compared with wires above ground. In 1888, 338 interruptions from storms were observed in underground wires, and in the above ground wires 2,375 cases of injury were reported. In regard to town telephone wires, it is worthy of remark that notwithstanding the violence of several of the storms in the towns having a telephone system, the accidents from lightning compared with former years were strikingly few, and the assumption does not, therefore, appear to be without justification that the wires spread over the roofs affords effective protection in equalising atmospheric electricity. The owners of overhead wires in New York should make use of this plea in the next law case they have.

News.—An advertisement, in a French contemporary, by the Compagnie Nationale d'Electricité Système Ferranti, says that "les machines Ferranti fonctionnent à Deptford," among other places mentioned. One must always go abroad for real news.

The Electrical Exhibition at Frankfort.—The committee of this exhibition, which is to be held next year, will have as its vice-president Herr O. von Miller, formerly director of the Allgemeine Elektricitäts-Gesellschaft.

Electric Traction Company.—This company is very busy in colliery work. Owners have not been slow to recognise the saving of expense when using electricity, and it is anticipated there will be great development in this special branch of electric traction. A new car for use on the roads is to be dispatched to Liverpool showing many minor improvements upon those used on the Barking line. As an instance of the great attention now given to traction, we are informed that enquiries are daily received for details of the work performed by the company. Boats are being built on the Clyde to be propelled by electricity, for use on the ornamental waters at the forthcoming exhibition. In connection with electric traction, we may shortly expect the launching of a very powerful company.

A New Telephone.—The Universal Telephone Company has brought into the market a telephone which it is claimed does not infringe any existing patent. It is of a most simple construction, consisting of an electro-magnet and celluloid diaphragm, the patent of George Lee Anders, which is worked under concession by the company. There is nothing which is likely to get out of order, and for domestic use it certainly appears to answer its purpose well. There are several forms in use, of which we give a few illustrations. A low price is asked for the instrument, and certainly, considering its good qualities, it ought to meet with ready adoption. Many are already in use, notably in the Bank of England and the Dock House, Leadenhall Street. The greatest distance to which this telephone is working is about five miles, this being on a line of the St. Pancras Iron Works Company.



PEDESTAL TELEPHONE

House-to-House Electric Light Company.—Over 12,000 lights are now supplied by this company, and many more houses will shortly be in a condition to receive the current. The largest order yet received is for the lighting of Bailey's Hotel, a palatial building of recent construction near Gloucester Road Station. More than 1,400 lights are installed. Since operations commenced many private installations have ceased to work, notably one of Mr. Gilbert's (of Gilbert-Sullivan fame), the residents preferring to have electric current supplied by the company.

New Application of Electricity.—By some chance a copy of an electrical paper found its way into the hands of a Thames' bargee, who, strange to say, cast his eye over it. There he found a mention of an automatic electric leak-finder. He went to his owner, pointed the passage out to him, and said, "I wish you'd get me one of them —— things to find the —— leaks in my —— barge. There's always some new ones to wet the cargo, and it's a —— of a trouble to have to work for 'em oneself?"

Britannia Company, Colchester.—We have received an illustrated catalogue of very ample dimensions showing the manufactories of this company.

Taxation of Machinery.—An attempt is being made to get, on the 16th April, a Bill for abolition of the rating of machinery, read a second time. The thing has been tried before, but failed to excite interest among M.P.'s generally. Greater efforts are being made this time to keep a house.

Spanish Electrical Company.—We gather from the Barcelona journals that the electrical supply company, the Sociedad Espanola de Electricidad, has effected several modifications in its statutes and regulations in consequence of the amalgamation with the firm of Messrs. Woodhouse and Rawson. A new council of administration has been formed, composed as follows: President, Louis Marté Codolar; vice-president, Albert Hoster, member of the London Chamber of Commerce; council, Sir John Stokes, vice-president of the Suez Canal, Manuel Maria Pascual de Bofarull, Frederick Rawson, member of the Institute of Electrical Engineers, José Espinós Stocklein, Frederick Ashby, merchant, of London, José Bofill Martorell, Thomas Harrison Lambert, of London; Enrique Parellada and Henry Rawson, solicitors; consulting engineer, Bernardino Martorell y Falp.

The Langhans Incandescent Lamp.—Mr. Langhans has recently manufactured an improved filament which will probably be a new development in the manufacture of incandescent lamps. The main characteristics of the Langhans lamp is, that it requires a very low vacuum, corresponding to about 1 mm. atmospheric pressure. So low a vacuum as this entirely obviates the use of the expensive and unhealthy mercury apparatus, as it can be obtained by a mechanical pump specially constructed by Mr. Langhans for the purpose. To achieve this, filaments made of carbon have been superseded by light emitters with a metallic (silicium) conductor. Filaments of this description, it is said, resist a temperature considerably higher than carbon filaments without being attacked by oxygen. This resistance indeed is so great, that the silicium filaments will incandesce for several minutes in the spent air without being destroyed. Notwithstanding the low vacuum, the life of the carbon filament is said to be equal to that of any of the best makes of carbon; it would be almost possible to do without a vacuum if the conductivity of atmospheric air would not cause too great a loss of heat, and thereby too great a consumption of current. The several processes already employed in coating with silicium the Langhans metallate or mineral filaments are simple and inexpensive, securing great regularity in the coating as well as affording a high degree of certainty in the predetermination of the voltage. Coating carbon filaments with silicium by the Langhans process and patents produces lamps consuming less current than lamps of carbon only, and, moreover, requiring but the same low vacuum as the silicium Langhans lamp. We are told that the new lamp takes only $2\frac{3}{4}$ watts per candle-power, but we require the data of practical experience before we can express any definite opinion upon this invention.

Execution by Electricity.—The Court of Appeal has confirmed the law passed by the New York States Legislature for executing criminals by electricity.

Institution of Electrical Engineers.—In the statement of accounts for the past year we find subscriptions for 1889 amount to £1,504 16s. 6d. After the payment of all expenses there remains in the hands of the bankers £316. The surplus of assets over liabilities amounts to £4,595 3s. 10d. The students of the Institution met last Friday at the Sanctuary, Mr. W. M. Mordey in the chair. Mr. Wightman read a paper on "Constant Current Regulators." A short discussion followed, in which the chairman, Messrs. Cirlo, Barton and Bone took part. A vote of thanks was then given to Mr. Wightman for his paper, and to Mr. Mordey for presiding. The meeting then terminated. At the next meeting, to be held on April 11th, Mr. G. Müller will read a paper on "House Telephones."

Quick Work.—The result of the Oxford and Cambridge Boat race, which was finished at $5.6\frac{1}{2}$ p.m. on Wednesday, was signalled to New York by the Direct cable, and reached that city at 5.8 p.m., Greenwich time, and was communicated to the Press by telephone a second later. The transmission between Mortlake and New York only occupied $1\frac{1}{2}$ minutes, and was not equalled by any other cable company.

Electric Lighting Tenders.—The estimates sent in for lighting the Workhouse extension of the Hackney Union form an interesting study. There are no less than 28 firms tendering for the work, and the amounts vary from £931 16s. 4d. to £1,685, with some small sums as extras or allowances. The tender of the Maxim-Weston Company, who prefer to employ dynamos of Crompton's construction, is less than that of the manufacturers themselves. The whole matter shows that estimating for electric lighting has not yet been brought to such a degree of high art as tendering for submarine cables, when sometimes the prices of several competing firms do not vary more than 10s. per knot, or less than 1 per cent.

The Death from Electricity at Brighton.—Yesterday at the Sheriff's Court the case of Garman v. The Brighton and Hove Electric Light Company came on for hearing. It was an action remitted from the High Court of Justice for assessment of damages, in which Emma Garman, of Brighton, sued the company to recover £1,000 as damages for the loss of her husband, who was killed by a shock from an electric wire in Messrs. Abby and Hallett's brewery, Brighton, last July. The jury returned a verdict for the plaintiff, and awarded £800 as compensation.

Telephonic Communication at Torquay.—Efforts are being made at Torquay with the view of securing telephonic communication between the two railway stations for the convenience of traders and residents. A promise has been made on behalf of the Great Western Railway Company that the proposal shall receive consideration, and it is hoped that negotiations may follow between the telephone and railway companies, resulting in the immediate realisation of this improvement, which can be effected at a very trifling cost, quite disproportionate to the convenience which it would be to the public. A suggestion has also been made that the General Post Office should be placed in connection with the telephone exchange, with a view to the receipt of telegraph messages intended for transmission by wire, but there is little prospect of this being accomplished on account of the exhorbitant charges of the Post Office for such a convenience.

Telephony in Germany.—Interurban telephony appears to be flourishing in Germany. There has been a general desire expressed in the Upper Siberian districts for telephonic connection between Berlin and Ratibor and its neighbourhood. Traffic has been so heavy on the Berlin-Breslau wire that it is found impossible to increase its work, and in consequence the advisability of establishing a second line is now under consideration.

Panics in Theatres.—During the first act of "l'Œuf Rouge" at the Folies-Dramatiques, the audience had its olfactory sense regaled with the odour of burning rubber to the accompaniment of smoke from the wings. M. Aurelien-Scholl, the well-known author and critic, then rose, and, addressing M. Gobain, one of the actors, inquired the reason of the unusual phenomenon, which was not mentioned in the programme. The simultaneous appearance upon the scene of an official of the fire brigade gave rise to a panic among the audience, which made for the exits, heedless of the exhortations of the actors and of some spectators who had kept their heads. It appears the principal conductor-wire had fired several yards of its rubber envelope, but no further damage was done, and the spectators, reassured, returned to their seats. A similar occurrence lately took place in a much frequented Vienna theatre. An electric wire broke and set fire to its rubber covering. Some jets of flame fell upon the stage, and a strong odour of burning filled the auditorium. Numbers of the spectators rose and struggled towards the exits. The panic, however, was only temporary, and the example of three arch-duchesses in the Imperial box contributed a good deal to allay the excitement.

Electricity in Mines.—Mr. W. E. Phelps, a prominent coal miner, of Elmwood, Ill., U.S.A., says that whereas formerly it cost him some $1,200 to operate the pumps by steam, the cost with electricity is less than $300. The value of electricity on its application to certain work in mines cannot, he says, be over-estimated. With the electric motor the pump can be moved to any part of the mine, and for less than $50 a discharge pipe can be driven or sunk to the proper level, and the circuit completed with wires drawn through a smaller pipe as often as necessary. When using steam, the prime factor of expense was the cost of of maintenance and operation, and each extension of the pipes meant a further consumption of power.

"A Far Look Ahead."—The author of this work has laid under heavy contribution electricity; in truth, to such an extent, that to live in the state described by the writer, the lot of man would be a monotonous one. Readers of this strange jumble are taken to the 96th century, in which is supposed to be realised the highest ideal of human happiness. The electric curricle is used on all occasions; the inhabitants rarely or never walk. There are no thieves; in fact, none of the things which make life at the present day worth living.

A High Tension Smoking Concert.—On Thursday evening, the 20th inst., a smoking concert was held at the Sir John Falstaff Concert Hall, Old Street, E.C., by the Ferranti String Band, and attended by about 600 of the engineering staff and *employés*. Engineers of several other electric lighting companies of the metropolis were present, and the occasion was taken to present Mr. Sparks (Mr. Ferranti's partner), with a handsome address and a tea and coffee service on the eve of his approaching marriage. It was only to be expected that Sparks should be visible in the chair, and that the conductor, not the concentric one, should break down under the high tension.

Electric Welding.—*Science* says: In accordance with instructions from the City of London Contract Corporation, Limited, Alexander B. W. Kennedy, F.R.S., Vice-President of the English Institute of Mechanical Engineers, recently visited the United States in order to see what progress has been made in the direction of the practical carrying-out of the Thomson electric welding process. His report is dated February 1. He visited the offices at Boston, and also spent about a week at their works at Lynn, Mass. He also visited five different works in the Eastern States (at Hartford, Ansonia, Brooklyn, and Trenton) where Thomson electric welders have been in use for some time (in some cases over a year) commercially. The report speaks favourably of the process.

Thunderstorms.—The *Quarterly Journal* of the Royal Meteorological Society, Vol. XVI., No. 73, contains the second report of the thunderstorm committee. In 1888 the society commenced the collection of systematic observations of thunderstorms over England and Wales, and a large mass of valuable information has already been obtained which is now being tabulated and plotted on maps ready for discussion. This will afford data for ascertaining the monthly and hourly frequency of thunderstorms, and also for tracing their path across the country.

Electric Phenomena of the Heart.—A special meeting of the Berlin Physiological Society was called by Prof. Dubois-Reymond on December 27th, in order to see a demonstration, by Dr. Augustus Waller, on man and other animals, of the electromotive action accompanying the beat of the heart. Besides the ordinary members of the society, the leading physicists of Berlin were invited, and Profs. Helmholtz and Kundt witnessed the experiments. Dr. Waller employed the capillary electrometer, the indications being magnified 1,250 times, and thrown on a ground glass screen in one of the lecture rooms of the Physiological Institute, and demonstrated the electromotive action of the heart in a horse and in a dog. The horse stood in a courtyard near the lecture room; electrodes were attached to his extremities by firm bands, and the wires from the electrodes were passed through the window to the electrometer in the preparation room adjoining the lecture room. The dog stood in the lecture room. In the library of the institute Prof. Dubois-Reymond allowed the demonstration to be made on himself, so that the pulsations might be seen directly through the microscope by all the members present. Mr. Waller's work in this direction is well known, and formed the subject of his introductory address delivered at St. Mary's Hospital, at the opening of the session, 1888-89. A Montyon prize was afterwards awarded to him in Paris for his investigations.

Snowstorm, Lightning, and Electric Cars.—Says a Boston U.S.A. contemporary:—"Bostonians were recently treated to a rare and beautiful thunderstorm, which occurred very unusually in the midst of a heavy snowstorm. One of the lightning bolts in its path to earth was unscrupulous enough to choose an electric car *en route*, and did some temporary damage. The other cars, however, continued to do their work nobly, and, outside of running a little behind time, owing to the extremely slippery condition of the rails, weathered the storm bravely.

Public Lighting by Electricity.—Mr. Henry Mavor, M.Inst. E.E., read a paper on this subject last week to the Glasgow Philosophical Society, and concluded with the hope that in Glasgow before long electric conductors would lie down with the gas pipe, and that the light of a new era would spread its radiance over every quarter of the city. This is somewhat flowery language for a scientific lecturer.

NEW COMPANIES REGISTERED.

Electric Meter Company, Limited.—Capital, £50,000 in £10 shares. Objects: To carry on business as electricians, mechanical engineers, and manufacturers of electrical apparatus and appliances generally. Certain patents relating to electric meters are to be acquired upon terms of an unregistered agreement entered into with the Corporate Trust, Limited. Signatories (with 1 share each): A. J. Pavitt, 94, Sandringham Road, Dalston; J. Barlow, 6, Charlotte Street, Portland Place; A. F. Stokes, 5, Birchin Lane, E.C.; H. J. W. Frost, 235, Queen's Road, New Cross; H. Comins, 3 & 4, Great Winchester Street; C. J. Lush, 75, Chancery Lane; H. Turner, 1, Stanley Road, Wimbledon. The signatories are to appoint the first directors; qualification, £100 in shares or stock; the company in general meeting will appoint remuneration. Registered office, 25, College Hill, E.C. Registered 22nd inst. by Walter Webb & Co., 23, Queen Victoria Street.

Thomas and Green, Limited.—Capital, £39,000 in £100 shares. Objects: To take over the business of paper manufacturers carried on by Messrs. John Thomas and Roland Green, at Wooburn, Bucks, and in conjunction therewith to manufacture gas and electricity for lighting and other purposes. Signatories (with 1 share each): Roland Green, Mrs. R. Green, of Maidenhead; James Thomas, Bisham, Berks; John Thomas and Mrs. John Thomas, Wooburn; Laurence Green and Herbert Green, Maidstone. The vendors are appointed managing directors for 14 years each, at a salary of £500. Director's qualification, £500 in shares, the company in general meeting will appoint remuneration. Solicitors, Messrs. Godden, Holme & Co., 34, Old Jewry.

OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

Whitehall Electric Supply Company, Limited.—An extraordinary general meeting of the shareholders in this company was held on the 27th ult., at 2, Bond Court, Walbrook, when it was resolved to wind up, Mr. Leonard B. Burns being liquidator at a remuneration of twenty guineas. The resolutions were confirmed on the 19th inst., and were duly registered on the 22nd inst.

Midland Electric Light and Power Company, Limited.—An agreement of 21st inst., between this company and Mr. Arthur Chamberlain, of Birmingham, provides for the allotment to the latter of 2,982 ordinary fully paid shares of £10 each in satisfaction of a sum of £29,820, part of indebtedness of the company.

Pontypridd Electric Lighting Company, Limited.—The first return filed by this company is made up to the 24th inst. The nominal capital is £10,000 in £5 shares, but only seven shares are taken up and upon these no call has been made. Registered office, 40, Mill Street, Pontypridd.

Foreign Pilsen Electric Light and Power Company, Limited.—The annual return of this company, made up to the 18th inst., was filed on the 19th inst. The nominal capital is £30,000 in £1 shares. 29,800 shares have been issued, the whole of which are credited as fully paid.

Notting Hill Electric Lighting Company, Limited.—At an extraordinary meeting of this company, held at 9, Austin Friars, on the 25th ult., the following resolution was passed:—"That Article 59 of the articles of association be altered by omitting the following words therefrom: 'Relating to the increase of capital of the company, the setting aside a reserve fund to meet depreciation of the property of the company, or any part thereof, or concerning or,' such words commencing in the third reading in the sixth line of such article." The resolution was confirmed on the 14th inst., was duly registered on the 17th inst. The article altered was to the effect that a member for each founders' share should have 1,000 votes, and for every £1 of founders' stock 100 votes on any question relating to increase of capital and reserve fund, but on other questions the same voting power as other shares.

The annual return of the company, made up to the 11th inst., was filed on the 18th inst. The nominal capital is £100,000, divided into 550 founders' and 9,450 ordinary shares of £10 each. The whole of the founders' shares and 6,317 ordinary shares have been subscribed. Upon seven founders' shares the full amount has been called, and upon 543 founders shares £2 per share has been called; upon 134 ordinary shares the full amount has been called; and upon 6,183, £2 per share. The calls paid amount to £14,734, and unpaid to £128.

CITY NOTES, REPORTS, MEETINGS, &c.

Newcastle District Electric Lighting Company.

ON Wednesday last week the shareholders of this company held their second annual meeting at the Crown Hotel, Newcastle, Mr. J. D. Milburn occupying the chair. There were also present Sir Benjamin Browne, the Hon. C. A. Parsons, Mr. H. C. Harvey (company's solicitor), Mr. J. B. Simpson, Mr. F. J. Snowball, and Mr. J. Patterson (secretary).

The following report was taken as read:—"The directors have to report that the company's central electricity supply station is now in full working order, and that up to the present arc and incandescent lamps, equivalent to 2,100 10-C.P. lights, have been connected to the mains of the company, and the work is proceeding for switching on further lamps, equivalent to 3,500 10-C.P. lights. The directors anticipate that in a very short time the company will have sufficient business to take up all the electric current which the present plant is capable of supplying. The delay in receiving the Board of Trade licence for the company to proceed has been got over by the directors being able to come to a private arrangement. It is as yet too early to give an accurate forecast of the financial prospects of the company, but the directors have no reason to alter the favourable opinion as to the future of the company that they have always held. Sir Benjamin Chapman Browne and Mr. Arthur Fenwick Wade are the retiring directors, and offer themselves for re-election."

The Chairman, in moving the adoption of the report, referred to the difficulty which arose in consequence of a technical error in the draft Board of Trade licence at the moment that the licence should have been handed to the company. After waiting several weeks the directors resolved to appeal to the Mayor and Corporation for leave to lay down their mains pending the receipt of the licence from the Board of Trade. The corporation considerately granted the company's request under certain conditions, and every effort was put forth by all connected with the working of company to make up for lost time. In order to minimise the inconvenience to the public, through the lifting of flags and crossings, an arrangement had been made between the company and the Newcastle Electric Supply for the division of the town into two districts with the exception of the Quayside, which was neutral ground or common to both. As regarded prospects, business was flowing in steadily. The total number of 10 candle-power lamps which could be efficiently connected with the company's station as at present completed would be about 9,000, of which probably not more than 6,000 or 7,000 would be simultaneously in use, thus leaving one generating machine and boiler always in reserve. Up to the present the company had connected with their mains 41 installations representing from 3,000 to 4,000 10 candle-power lamps, and orders for current have been given for about 1,500 or 2,500 more, and many others were in prospect. It would appear therefore that the company would shortly have more business than it could manage without increasing its generating power, and it might be necessary ere long to expend more capital to make such increase. Having referred to the judicious provisions made for future requirements, and observed that the company had space for generating plant equal to eight or ten times its present productive power, he went on to say that the managing director (the Hon. C. A. Parsons) had recently been experimenting with arc lighting in conjunction with the alternating current system, which was the system adopted by the company. Several large arc lamps had been erected and been very successful, and the directors believed they would be able to undertake, at an early date, the partial lighting of the streets of this city, especially where brilliant illumination was desired. Alluding to the uses and demands for electricity, he said it was to the tramways that they must first turn their anxious attention. He believed the directors of these would not remain long in the back ground when a safe and economical scheme for electric traction had been indicated to them. Last year, when he announced the policy intended to be pursued by the directors of the company, he had said there was no intention to enter into any insane competition or into a death-grapple with gas, and he thought it would be some time yet before electricity would vie in cheapness with gas. He denied that the electric light was more dangerous than other lights, and remarked that, if properly conducted, accidents were very rare. In England there had been a great immunity from accidents, and this he attributed to the extra care exercised in these matters by the Board of Trade. The light as supplied by this company has given great satisfaction to its consumers. Not one single hitch or accident had taken place, and not a single complaint had been made, and they had every reason to be extra proud and satisfied with the high quality of the light supplied. He complimented Mr. Parsons upon his management; the engineers of the company, Messrs. Hunter and Bigge; and also Mr. Patterson, the secretary. He concluded by saying that altogether the directors had very great pleasure in stating that they were perfectly satisfied with the scientific department of the company. They could not very well yet, from the experience they had had, go into the financial prospect, but so far as they could say, and so far as their experience had gone, they had every reason to hope for success. They were doing their best in every direction to increase the business of the company and to keep down expenses. They hoped that next year, when they came before the shareholders then, to lay a satisfactory report before them and to be able, if possible—they could not make any promise—to give them some substantial history of their operations.

Sir Benjamin Browne seconded the adoption of the report, which was agreed to.

Sir Benjamin Browne and Mr. A. F. Wade, the retiring directors, were re-elected, and Messrs. Strachan and Hill were again appointed auditors.

It may be stated that the company have laid down 14,200 yards of main cable, and that the smallest cable is capable of carrying a current sufficient for 1,000 10-candle-power lamps. There are four circuits in the city—one for the Quayside, two for Granger Street, and one for Clayton Street and Barras Bridge.

The meeting closed in the usual way.

The Telephone Company of Egypt, Limited.

IN the report of the directors for the year ending December 31st, 1889, presented at the seventh ordinary general meeting of the company, held at the offices of the company, 14, Austin Friars, in the City of London, on Tuesday, the directors state they have the pleasure to submit to the shareholders their report and balance sheet for the year ending December 31st, 1889. After writing off a sum of £250 2s. 11d. for depreciation, and providing for the interest on debentures, the net profit for the year is £4,011 0s. 5d. Adding to this amount the sum of £1,069 6s. 11d., brought forward from 1888, the balance available for disposal is £5,080 7s. 4d. Out of this the directors recommend a dividend of 6 per cent. for the year on the preferred shares, free of income tax, which will absorb £3,621 6s., leaving £1,459 1s. 4d. to be carried forward.

The amount brought into the credit of revenue account, in respect of subscriptions and rentals, shows but a small increase over the previous year. This is due, partly to a falling off in the number of subscribers connected during the year, and to the elimination of some overdue subscriptions, the realisation of which the manager reports as doubtful.

A further growth of the exchanges at Alexandria and Cairo does not appear probable for the present, and the directors are therefore endeavouring to extend the use of the telephone to other towns in Egypt.

They are glad to be able to announce that an exchange was opened at Port Said on the 28th January, and, according to the latest advices received, 20 subscribers had been connected. The manager anticipates that before the close of the current year this number will be materially increased. The directors hope also to be able to establish a small branch at Assiout during the next few months.

At the meeting Mr. Alfred Fraser occupied the chair.

After the report had been read, the Chairman said he had not much to add to what was written therein. The meeting was aware that the company possessed installations in Egypt in five places, viz., Alexandria, Cairo, Zagazig, Mansoura and Port Said; he hoped they might shortly increase that number. They were now negotiating with the Egyptian Government with a view to the establishment of an installation at Assouan. He was happy to say, with reference to the Port Said installation, which had been very energetically established by their manager there, that they were enabled by the help of their colleague, Mr. Grëwing, to have the co-operation of Sir Rivers Wilson in obtaining the permission of the Suez Canal Company to place a cable across the canal, which would place them in telephonic communication with the coal depôts on the other side. The Suez Canal Company had also given them a subscription which he thought would enable the telephone company not only to increase its subscribers at Port Said, but possibly at other places on the canal up to Suez. Since they last had the pleasure of meeting, they had lost one member of their consultative committee in Egypt, viz., Mr. Chapman, the agent of the P. and O. Company, which had now established their agency at Port Said instead of Alexandria. In the report, the directors said they did not expect any great development at present of the business at Cairo and Alexandria; he himself thought that, when the prosperity of Egypt increased, the company's business, at Cairo, at all events, would likewise increase. When Mr. Chapman resigned his seat on the consultative committee, the directors thought fit to appoint in his place a gentleman who had been very useful to the company in Egypt at times, viz., Mr. E. J. Manuk, who had since proved himself of great use in the company's relations with the Egyptian Government and its functionaries. The company's business in Egypt had been very ably conducted by its agent, Mr. Evans, and in Mr. Begni it had a very able and satisfactory manager. The shareholders would be quite justified in giving their thanks to Messrs. Evans and Begni, and to their Egyptian staff in general. The work at home had also been very satisfactorily carried on by Mr. Chalmers and the staff. He begged to move the adoption of the report and the accounts, and the payment of a dividend of 6 per cent. on preferred shares, free of income tax.

Mr. Henry Grëwing seconded the motion, which was carried unanimously. Mr. Thos. Lloyd was re-elected a director on the motion of Mr. Grëwing, seconded by Mr. Wm. Addison, chairman of the Oriental Company, and Messrs. Price, Waterhouse & Co., were reappointed auditors at a salary of £15.

The Direct Spanish Telegraph Company, Limited.

THE report and accounts of the directors for the half-year ended 31st December, 1889, presented at the general meeting of shareholders, held on Monday last, show, after providing for debenture interest, a balance to the credit of profit and loss of £6,361 2s. 7d. The traffic receipts are in excess of those for any previous half-year, and show an increase of £1,592 2s. 6d. as compared with the corresponding half-year of 1888. The working expenses are £690 10s. 4d. in excess of those for the corresponding period of last year.

The company's cables and the land lines in connection with them have continued in good working order throughout the half-year.

Owing to the increase of the company's business it became indispensable to remove the London telegraph station to more suitable and extensive premises. The directors have therefore taken on lease No. 74, Gracechurch Street, which has been fitted up so as to meet the development of the traffic and which was opened for business on the 20th July last.

Of the balance of profit and loss, £2,500 has been put to the reserve fund, which now amounts to £17,515 19s. 8d., and there remains an available balance of £3,861 2s. 7d. Out of this amount the directors recommend the payment of the dividend at the rate of 10 per cent. per annum on the preference shares, and a dividend at the rate of 6 per cent. per annum (free of income tax) on the ordinary shares, making with the previous distribution 5½ per cent. for the year 1889, against 4½ per cent. in 1888. This will admit of a sum of £846 18s. 2d. being brought forward to meet possible contingencies. The dividend warrants will be issued on the 1st April, 1890. Mr. Etlinger and Mr. Denison Pender are the directors retiring by rotation and offer themselves for re-election. The auditor, Mr. Herbert R. Duke, retires, and offers himself for re-election.

The Chairman said the meeting would have seen by the report that the company had earned £1,592 in excess of the amount which was realised in the corresponding period of last year. They had carried 17,260 more telegrams, or 155,192 more words, and he was pleased to see that in the half year under review there had not been any further decrease in the length of messages, the average length of which was 10·48 words. Ever since code language and the word tariff "pure and simple" (by which was meant a single word signifying whatever the sender pleased and which was charged for as a single word only), were introduced by the companies there had been a steady persistency on the part of the users of the cables to reduce the number of words in their telegrams, until at last in their own company they had reached a point at which 35 per cent. of the messages were under five words. Were the reduction in the length of messages to stop there they might take comfort from the fact that merchants could now utilise the telegraph for small transactions and for business inquires which might have no probable result. The growth of telegraphy was no doubt due to such causes, and therefore the companies did not look upon cheap telegraphy with unmitigated horror, especially where there were large communities likely to use it. Unfortunately, whenever there was a reduction of tariff there was also an initial loss. They knew that at the forthcoming telegraph conference to be held in May next, some new terms would be introduced. In the case of their company they were working with a tariff so low that they had a right to expect that a minimum charge had been established; but they could not be sure of this. Some administrations looked with an unfriendly eye upon the company's poor 4½d. a word; but happily there were others which considered that the reduction had gone too far, and the great majority of European states recognised that they were losing money on their own telegraph services. Some of the shareholders might have noticed that the company was carrying forward a sum which was unusually large for it, viz., £846 18s. 2d. The company's expenses had increased to £690, not all of which was due to salaries, but some of it to the increase of rent and taxes for larger premises, more stationery, more printing, more new instruments and improvements in their stations. The directors desired to cling to that sum, not only because the action of the conference might still further affect the company's revenue, but also because even if their prosperity continued, they would only be acting prudently in laying by a greater or less amount of special reserve for the reduction of debentures. The directors accordingly recommended a dividend of 6 per cent. per annum on the ordinary shares, leaving that £846 to carry over. They had 60,000 of debentures at 6 per cent, and some plan ought to be adopted for dealing with them when they became due in 1894, either by creating a special reserve by calling up the £1 per share still uncalled, or by increasing the ordinary capital, or by renewing the debentures at a lower rate of interest should the reserve be as good as they hoped it would be when the time came. The directors felt that 6 per. cent. was as much as they ought to divide at present. He was happy to say that France had given them the use of a direct special wire between the Paris Bourse and the Marseilles office, so that the transmission of their telegrams to and from Barcelona was much accelerated, and their traffic consequently much increased. Spain had also given them a good wire from Bilbao to Madrid. The chairman then moved that a dividend at the rate of 10 per cent. per annum (less income tax) on the preference shares, and a dividend at the rate of 6 per cent. per annum (free of income tax) on the ordinary shares, making, with the previous distribution, 5½ per cent. for the year ending 31st December, 1889, be paid, and that the report and accompanying accounts be adopted by the shareholders.

Mr. Etlinger seconded the motion, which was carried unanimously.

Messrs. E. Etlinger and John Pender were re-appointed directors, and Mr. H. R. Duke auditor of the company, and the meeting broke up with a vote of thanks to the chairman and directors.

Stock Exchange Settlements and Quotations.—The Committee has appointed April 9th for the settlement of the following companies, the same securities to be placed in the official list:—Crompton & Co., preference shares 1 to 20,000; Westminster Electric Supply Corporation, ordinary shares Nos. 101 to 42,953; United River Plate Telephone Company, £146,128 Five per Cent. Debenture Stock (part of £200,000 authorised).

Callender Bitumen Telegraph Company.—At a recent meeting of this company it was resolved to declare a dividend at the rate of 7½ per cent. on the ordinary shares, which compares with 2½ per cent. in previous years. We understand this company is well supplied with work to the end of this year.

The Eastern Extension, Australasia and China Telegraph Company, Limited.—The directors recommend a further distribution of 2s. 6d. per share and a bonus of 2 per cent., making 7 per cent. for the past year, a balance of £58,494 being placed to reserve.

The Notting Hill Electric Lighting Company, Limited, notify that share certificates are now ready and can be exchanged for the bankers' receipts for amounts paid on application, allotment and first call.

Westminster Electric Supply Corporation.—A meeting was held on Wednesday to confirm the alterations resolved to be made in the articles of association a week ago.

Globe Telegraph and Trust Company.—The board notify an interim dividend of 2s. per share, payable on the 18th proximo.

Elmore's Wire Manufacturing Company.—Letters of allotment in this company were posted on Monday last.

TRAFFIC RECEIPTS.

The Brazilian Submarine Telegraph Company, Limited. The receipts for the week ending March 14th, 1890, amounted to £4,644.

The Western and Brazilian Telegraph Company, Limited. The receipts for the week ending March 21st, after deducting the fifth of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited, were £3,991.

THE LONDON CHAMBER OF COMMERCE.

A special meeting of the Electrical Trades Section was held at the offices of the Chamber on Wednesday, and was rather poorly attended.

Adjustment of Labour Disputes.

The meeting proceeded first to consider the appointment of representatives of employers on a conciliation committee (composed equally of employers and employed) under the provisions of the labour conciliation scheme of the Chamber on behalf of the electrical and allied trades.

The Chairman, Mr. Crompton, said the question of avoiding labour disputes had occupied the attention of most distinguished members of the council and of the Chamber, and the matter had reached a much more advanced stage than possibly they were aware. They had now got to the point at which they wished to have the support or, at all events, the opinions of each of the individual sections of the Chamber. The electrical section had to decide whether in its case it was necessary to attempt the solution of the question. The members of the trade were not as yet a large number, but they might be a very much larger one in the future.

The Secretary then further explained that the main effect of the scheme was to promote the establishment of committees of a particular trade, equally composed of masters and of men, to form committees of experts to deal with any difficulty that might arise between employers and employed, after which, if they failed to agree, the matter would be referred to the London Conciliation Board, as a kind of superior court composed of delegates of these trade committees, representing capital and labour equally, and not outsiders. If that second reference failed then arbitration might come in.

After a short discussion, on the motion of

Mr. Gray, it was resolved, in view of the smallness of the meeting, that the circular which had been printed and was before the meeting, be sent to the whole of the members of the section, and that the conciliation committee of the Chamber be instructed to prepare a list of gentlemen to be asked to serve on such a committee as mentioned in the circular.

Municipal Corporations and Provisional Orders.

The next matter before the meeting was to consider how far municipal corporations and companies should be authorised to transfer their provisional order powers without reference to the Board of Trade or to Parliament.

Mr. Hammond said the Board of Trade had placed companies under the obligation of not transferring their orders unless, practically, with the consent of Parliament. He did not wish to raise a discussion as to whether that was a fair provision, but he urged that local authorities who obtained provisional orders should be placed under the same obligation. When a company applied for an order a very rigid scrutiny took place as to whether it should have it, but the local authority was not placed under such scrutiny; the mere fact of its being a local authority was sufficient to obtain the order for it. Yet, practically, the local authority might be only applying with the avowed object of passing the order on to some particular company, which, if it had applied on its own account, might never have obtained the order. He thought they should urge upon the Board of Trade that local authorities applying for provisional orders should be placed under the same obligations with regard to transfers as public companies were.

Prof. Forbes asked whether it was a fact that local authorities were in a different position from companies in regard to transfers?

The Chairman said at the present time there was no difference in their position. He believed it had been the intention of the Board of Trade, when issuing its remodelled order, to make it apply to both local authorities and companies. But, in an unofficial way, he had seen an order in which the Board proposed to give the local authorities this power of transfer. The question before the meeting was: What is best for the electrical industry as a whole? A great deal was to be said for both sides. In the first place money was very easily raised by local authorities, and they were in a position to carry out certain works themselves and to let out others. It might be argued, therefore, that giving the power to the local authorities might actually increase the work which would be given out to manufacturers of electrical appliances. On the other hand, it was undoubtedly a hardship that local authorities should, by means of their power of transfer, be able to delay availing themselves of provisional orders they obtained with a view of, it might be, burking the industry.

Mr. Erskine said if the Board decided to give this power it might possibly be induced to make the rules more stringent, so that public bodies would be bound to undertake the work themselves.

Mr. Hammond said he thought the industry would be better, on the whole, in the hands of a Parliamentary Committee.

The Chairman said the question to be discussed was whether a deputation should go from the section of the Chamber representing the supply companies, or from the industry, as a whole, as having reference to a matter which seriously affected the interests of the industry.

Prof. Forbes said a great many cases had come under his notice in which local authorities plainly did not want the work to be done at all.

Mr. Hammond suggested that a deputation should wait upon the Board of Trade and request it not to make any alterations in its order without first giving the Chamber an opportunity of discussing the matter with it.

The Chairman said as the Board had not yet issued its remodelled order, the step suggested might only involve the section in a snub. Their only chance of affecting the matter was to organise opposition in Parliament.

Mr. Hammond said whichever way they decided, they could hardly bind the section in so small a meeting. He therefore moved:—"That the transfer of provisional orders possessed by local authorities be assimilated to that by companies; and, with a view to this being done, the supply companies be invited to co-operate in the next session of Parliament to be represented by counsel as a whole."

The motion was seconded by Mr. Swinburne, and carried unanimously.

Information Wanted.

The Chairman read a letter, which it is proposed to send to the secretaries and managers of electrical supply companies and others engaged in the electrical industry, requesting them to bring before their board of directors or board of management, as the case might be, that, having regard to the desirability of a freer interchange of ideas between electrical engineers in all countries of the world, it has been proposed at a meeting of the Electrical Section of the Chamber of Commerce to publish in a quarterly report the following data obtained from supply companies in all parts of the world—viz., cost of production, cost of manufacture, material, fuel, labour, wear and tear, and other charges which go to make up the cost of production; and to obtain the opinions of such boards as to the desirability or otherwise of the scheme, which comprehends the appointment of as many corresponding members as possible to form an international society; the terms of membership to be at first a small subscription to meet the cost of printing and posting; the members to be required to communicate with the head office in London, by letter, giving in general terms the data above mentioned.

The letter was adopted, and on the motion of the chairman, seconded by Mr. Hammond, it was resolved that it be printed and circulated at once.

The meeting then broke up.

ELECTRICAL ENERGY METERS COMPETITION.*

Report of the Commission.

The Commission entrusted with the judging of the apparatus in the competition, appointed to take place by a prefectorial order, dated March 2nd, 1889, has concluded its labours, of which the report, which we have now the honour to present, is a faithful, although succint, resumé. It concludes with a series of propositions which are justified by the very peculiar conditions under which the competition took place. They represent the unanimous opinion of the Commission, formed upon several months' practical study of the apparatus submitted to it for examination.

In spite of the shortness of the time allowed to the competitors between the opening of the competition, which was only announced early in March, and the 25th May, the date fixed as the outside limit for sending in the apparatus, twenty eight competitors were able to respond to the appeal. A complete list of these is annexed to the report.

The Commission's first care was to draw up the list of competitors, to classify the apparatus, and to strike out such of the competitors who had not complied with the conditions laid down. Thus the number was reduced to 16 and the number of apparatus to 28, of which 16 were quantity and 12 energy meters.

The whole of these, when not designed exclusively for the measurement of alternating currents, underwent many series of experiments, representing in the case of such of them as were submitted to the entire test, many hundreds of hours of intermittent working, at frequent intervals, spread over a space of four months, the limits of each interval being fixed by the inventor or maker of the instrument.

The observations made in respect of each meter will be found set out in the part which relates to the details of the experiments and the modes of measurements.

If, taken as a whole, the results obtained are not so favourable as we were justified in hoping, we may attribute this principally to the hasty organisation of the competition and the shortness of the time allowed to the competitors for preparation. Some of the apparatus displayed considerable ingenuity, a satisfactory simplicity, and called for no serious objection in operation; yet, when submitted to the tests, caused nothing but miscalculations, owing to the rudimentary nature of their construction, which was manifestly insufficient both in the *ensemble* and the details.

As regards a certain number, they only appeared to require some slight modifications and improvements in order to give them the necessary industrial qualifications.

The experiments, which took place at the Hotel de Ville or at the electrical laboratory attached to the Ecole de Physique, or at the laboratory of industrial chemistry belonging to the City of Paris, under the superintendence of MM. Cretien, Laffargue, Roux, and Lecomte, enabled the Commission to proceed by successive eliminations, and to submit to the most searching tests such of the apparatus as had given satisfactory results.

The Commission was unable to find amongst these a single one to which it could justly award the prize of 10,000 fr. for an *entirely satisfactory* meter on the terms of the prefectorial order; but it did, nevertheless, consider some as worthy of serious encouragement.

They were five in number, viz., those of MM. Cauderay, Aron, Brillie, Blondlot, and Jacquemier. M. Cauderay is one of the foremost of those inventors who paved the way and devoted themselves to the discovery of a practical meter, and have made the greatest progress in the matter. We may fittingly particularise the 5-ampères meter as most satisfactory in the regularity of its working, except for a want of precision when the current is small, a defect which doubtless could be remedied by a better shaping of the integrating arrangement.

Moreover, M. Cauderay's meters have the sanction of practice, and are in very general use in the central stations in France.

M. Aron's apparatus occupy in Germany a position equivalent to that of Cauderay's in France. The only serious objection to this system is the difficulty of maintaining the synchronism of the two pendulums which constitute the essential organs of M. Aron's meter. Recent experiments made since the competition took place seem to indicate that the difficulty has been overcome.

M. Brillié's energy meter was theoretically considered one of the most satisfactory of its class, but unfortunately the solitary apparatus exhibited—a somewhat complex and delicate one as regards construction—frequently came to a standstill, nor experimentally did it furnish all the results expected from it. The inventor has nevertheless the peculiar merit of having constructed the first example of his system entirely by his own hands.

M. Blondlot's energy meter was remarkable for simplicity of principle and ingenuity of mechanism. The defects of a hastily constructed instrument are without doubt the cause of the unsatisfactory results under experiment.

Lastly, if M. Jacquemier's quantity meters were below the mark, the Commission had nevertheless occasion to observe one for energy whose regularity and precision in work were satisfactory, notwithstanding complexity in the integration mechanism.

In the course of these experiments the Commission undertook, at the request of the administration, to submit to experiment some other systems which were disqualified from competing by reason of lateness, and as regards which the Commission expressed no opinion in the present report, beyond saying that the satisfactory results obtained with some of them are confirmatory of the opinion already expressed, that the successes would have been greater if the competitors had been allowed time to finish and to test their apparatus. Moreover, certain inventors were rightly or wrongly frightened away by the clause which reserved to the City of Paris the free and unrestricted right to manufacture the prize exhibits.

It is only fair to remark, also, that the majority of the apparatus which showed the best under experiment were those which have already obtained the sanction of practical experience upon a more or less extensive scale.

None of the apparatus having given entire satisfaction the Commission considers that it would be advantageous to adjourn the competition, and to modify also the conditions in conformity with the draft programme annexed to this report. The Commission has not thought fit to undertake the testing of meters intended for alternating currents, as to do this it would have been necessary to await the operation of the Halles electric station. It has formulated the following

Propositions.

The Commission did not feel called upon to award the prize of 10,000 f., nor yet the prizes mentioned in Article 2 of the prefectorial decree of March 2nd, 1889.

Nevertheless, by way of recognition of the efforts made by inventors and of the results already acquired, the Commission proposes to make the following awards by way of encouragement:—

A sum of 2,000 f. to M. Cauderay for his apparatus taken on the whole.

A sum of 2,000 f. to M. Aron for his apparatus, taken on the whole.

Three sums of 1,000 f. each to MM. Brillié, Blondlot and Jacquemier, for their respective energy meters.

The competition to be adjourned to April, 1890, and the official announcement thereof made as early as possible to give the competitors the time necessary for the completion and perfecting of their apparatus.

Those meters, which have been awarded as above not to come under Article 2 of the decree of 2nd March, and the inventors to be free to take part in the fresh competition.

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* *L'Electricien.*

For this fresh competition the City of Paris abandons the clause authorising it to manufacture the prize meters free of royalty or other compensation.

The terms of the above report have been approved unanimously by the Commission.

Dated Paris, *December 14th*, 1889.

[Here follow names of President and members of the Commission.]

Persons, &c., Admitted to the Competition.

Names of Competitors.	Quantity Meters.	Energy Meters.
	Ampère-hour Meters.	Watt-hour Meters.
1. Aron	4	2
2. Batault	1	1
3. Bauer	1	1
4. Blondlot	1	1
5. Brillié	1	1
6. Cauderay	1	2
7. Clerc...	1	2
8. David ...	1	1
9. Desroziers	1	1
10. Ferranti	1	1
11. Ferranti-Borel ...	1	1
12. Jacquemier... ...	3	1
13. Miller	1	1
14. Richard	1	1
15. Trouvé	1	1
16. Weber	1	1

PROPOSED PROGRAMME OF THE 1890 COMPETITION.

1. The competition to be open to all inventors of electric meters, whether applicable only to continuous currents or only to alternating currents, or to both simultaneously.

2. The apparatus presented may be quantity meters (ampère-hour-meters), or energy meters (watt-hour-meters).

3. Each meter must furnish a direct reading and enable the consumer to calculate for himself the quantity consumed.

4. The meters must be adapted to small consumers; the quantity meters must start from a current of $\frac{2}{10}$ths of an ampère, the energy meters from a consumption of 20 watts.

5. The meters, accompanied by an explanatory notice, must be lodged at the Hotel de Ville in a sealed envelope, at the office of the sub-director of works, before August 31st, 1890. This is imperative.

6. The meters to be submitted to the judgment of a commission composed of nine members, five being appointed by the municipal council and four by the administration.

7. The meters to undergo comparative tests with a view to demonstrate :—

Their exactness as regards the scale of quantities.
Their practical value, regularity in work, simplicity, net cost.
The energy expended in working.
The trouble involved by them in the distribution of the current.

8. A sum of 13,000 fr. to be distributed under the following conditions :—

10,000 to the inventor producing a meter satisfactory in all respects, and applicable equally to alternating and to continuous currents.

Where the meter is applicable only to one of these two kinds of currents, the inventor to be entitled to only a moiety of the award.

Awards amounting to 2,000 fr. in the case of meters intended for continuous currents and alternating alike, and of 1,000 fr. in the case of those applicable to one kind of currents only may be made to inventors whose apparatus shall have realised important improvements.

Electric Bells in Omnibuses. — The Brighton omnibuses are to be fitted with electric bells, by means of which passengers, as well as conductor, can signal for the stoppage of the vehicle.

STOPPAGE OF THE JULIEN CARS IN BRUSSELS.

A VERY important decision was arrived at by the Brussels Tramways Company at the general meeting held a few days ago. About four years ago the Administrative Council of the company, on the motion of the president, resolved to introduce electric traction on one portion of the company's lines, and accordingly three accumulator cars were started.

The results obtained with these cars have been unsatisfactory from a financial point of view, although as regards working they were fairly successful, so the company has decided to discontinue running the electric tramcars from the 1st May next and to return to horse traction. The reason for this action is explained in the report presented at the meeting and from which the following details are abstracted :—

The service of electric tramcars has caused a deficit of £1,144, and this sum forms the difference between the cost of electric and horse traction. The importance of this sum is partly due to the frequent modifications necessary during an experimental period, and on the other hand to the fact that, having only three cars in operation, although the installation would have allowed of a larger number being employed without increasing the general cost, these three cars alone have tended to increase the cost of electric traction. The number of cars was not increased, because the expenses of equipment would have been considerable, and also because the mechanism of the motors employed was not very satisfactory. The company considers, after having had an experience of electric tramcars for four years, that that period has been sufficient to prove that whatever reductions may be made in the maintenance of the accumulators, and whatever the possible improvements in the mechanism of the motors, accumulator traction is not practically applicable to the company's system from a remunerative point of view, bearing in mind the particular conditions of the service. After referring to electric traction in other countries, the company concludes that from the experience at Brussels the most economical system of working tramcars is by animal traction. These, then, are the reasons, says *L'Ingenieur Conseil*, which have caused the company to decide to abandon electric and substitute horse traction on the 1st May.

Several of the newspapers published in Brussels severely criticise the action of the tramway company, and they are almost unanimous in their disapproval of the proposed change. *La Gazette*, in a long article on the subject, states that the adversaries of electric traction affirm that the cost per car kilometre is 4d. or 6½d. per car mile, whilst the advocates of the system maintain that the cost is only 2½d. per car kilometre or 4d. per car mile. That journal then goes into figures and endeavours to show that the cost per car mile in the two systems of traction, apart from the maintenance of the accumulators, is slightly less in the case of electric cars.

The action of the tramway company in abandoning the electric cars after four years' service will no doubt be the death blow to accumulator traction in Belgium for some time to come, but it must be remembered that the cars have been worked under disadvantageous conditions. They are of small capacity, and the line traversed by them has some none too easy gradients. Moreover, although only three cars were provided, the station in the Rue Juste-Lipse was arranged with machinery sufficient for working eight cars, and this in itself was a disadvantage, since the general expenses of eight cars would be about the same as when only three were employed. It is to be regretted that these cars will shortly disappear from the Brussels streets, but their failure commercially will doubtless cause the English company working the Julien system to exercise greater care in carrying out the line now under construction in Birmingham.

ACCUMULATOR CARS IN PARIS.

ABOUT six months ago the Northern Tramway Company in Paris commenced the running of four electric tram-cars on the line from Levallois to La Madeleine. The cars are self-contained or accumulator cars, and were originally started as an experiment to see whether accumulators could be satisfactorily employed. The electrical energy is supplied by Faure-Sellon-Volckmar cells having twin plates. The number of cells in each car is 108, and they are placed in 12 boxes, each containing 9 cells in series. Each cell weighs 33 lbs., and the total weight of the battery is nearly 32½ cwts. The twelve boxes are placed in four lockers, situated at the angles of the car, four carried at the front and eight at the back of the car. The connections are so arranged that on putting the cells in place, they are automatically grouped three in series, thus forming four groups of 27 cells each. These groups can for working purposes be coupled in four different ways. They can be arranged in parallel or in two groups parallel; three groups can be run in series, the fourth being in parallel with one of the three others, or the four may be connected in series. There is provided a fifth connection, which is obtained by means of an auxiliary commutator, which regulates the inequality of the discharge caused by the third method of coupling up. These connections are effected by means of a commutator in the shape of a wooden cylinder, having contacts on its periphery. These contacts are connected to each other by inner pieces insulated from the metal axis of the cylinder. The positive and negative poles of the four groups correspond to eight fixed brushes. The cylinder is operated by means of a crank.

A Siemens motor, which is placed under the front of the car, runs normally at 1,000 revolutions, but a speed of 1,600 turns can be attained. The power is taken from the motor by an endless rope running over a set of gearing actuating the car, and which reduces the speed of the motor in the proportion of 26 to 1. The motor is reversed, and the car backed by means of a special arrangement, comprising double V-shaped brushes. A single branch of the V of each brush touches the collector, but by causing the brushes to move by means of a lever the branches in contact are raised, and the other two are placed at 90°; thus the direction of the current is reversed, and consequently that of the car. The weight of the car is 3½ tons, making, with accumulators, a total of 5 tons 2½ cwts. The cars each carry 50 passengers, and run normally at 6¾ miles an hour. At this speed on the level the power required is 4½ electrical H.P.; on an incline of 1 per cent., 8 H.P.; on an incline of 2 per cent., 11½ H.P. At 5½ miles an hour, on a gradient of 3 per cent., 12½ E.H.P. is required; and 15½ E.H.P. is necessary on a 4 per cent. gradient. When running at 3 miles an hour on a gradient of 5 per cent. the E.H.P. is 10½. The French Electric Accumulator Company estimates that the cost of electric traction on the line in question amounts to 30 centimes per car-kilometre, or about 4¾d. per car mile.

ELECTRICITY AS APPLIED TO STREET RAILWAYS.

By FRANK J. SPRAGUE.

(*Concluded from page* 333.)

Having thus touched upon the characteristics such as I would propose for a railway system of this kind, let us resume the consideration of our proposed line between New York and Philadelphia, and try to form some idea of the electrical pressure which would be required, the service which could be demanded, the number of cars which could be handled, the speeds which could be maintained, and the number of stations which would be required to operate the stations. We will assume for the purpose of this investigation an overhead conductor in the form of a solid rod one inch in diameter over each track, or, if you please, a smaller rod over each track and a main conductor making up the equivalent capacity proposed, and a track of equivalent capacity. I take this arbitrary size because it is convenient for the purposes of our calculations and because it falls well within the limit of expenditure which such a system would warrant. For instance the American Bell Telephone Company has a line of long distance telephone wires rounding from New York to Boston, a distance of about 300 miles, nearly three and a half times the distance which we are considering. On these poles are about 70 wires each of No. 12 copper. The aggregate area of these conductors is over 800,000 circular mils, and the total weight of copper on this line which is used simply for telephonic purposes, is about 40 per cent. more than the weight of two copper rods an inch in diameter running from New York to Philadelphia. If the investment is a reasonable one in the telephone system, cannot we certainly consider it a reasonable one in that larger field of the transmission of power of which we are now speaking?

As I have stated, of the number of trains which in 13 hours leave Jersey City for Philadelphia, twelve usually make only one or two stops. Allowing 60 cars this would be about one car every thirteen minutes. This interval of thirteen minutes is nearly as short as would be desirable between cars running at an average speed of a mile a minute, no matter how perfect the block system, and it would be necessary, possibly, to run these cars in double car units. We will assume for our purposes the size of a car such as is used on the elevated road of Brooklyn Bridge in New York, which would with motor and passengers weigh from 20 to 25 tons, or a total of, say, 50 tons for our unit. The formula to determine the size of conductor for a single transmission of car is

$$\text{C M} = \frac{15{,}666\, n\, l}{e\, v\, p}$$

where n = the number of horse-power, l the distance in feet, E the potential at the motor, v the fall in potential and p the commercial efficiency of the motor. If we assume the station situated in the middle of the line; that is, at the best point, and the work divided equally at the middle section on each side, then L being the length of line we have the formula

$$\text{C M} = \frac{1{,}566\ \text{N L}}{4\, e\, r\, p}$$

This will be practically the same if the work is distributed over the entire line.

If more than one station is used then the formula will become

$$\text{M} = \frac{15{,}666\, m\ \text{L}}{4\ \text{E}\, v\, f\, 5^0}$$

that is, the size of the conductor would vary inversely as the square of the number of stations, if properly distributed. V may be expressed as a fraction of E, and for practical purposes we will let $v = 1{\cdot}9$ of E and P, such that

$$\frac{15{,}666}{\text{P}} = 16800$$

that is P = about 93 per cent. Then we have

$$\text{C M} = \frac{37{,}800\, n\ \text{L}}{\text{E}^2\ \text{S}^2}$$

which may be expressed thus, that the size of the wire varies inversely as the square of the product of the number of stations and the electromotive force.

We may also note that with any fixed size of conductor the electromotive force and the number of stations vary inversely, a somewhat important fact to remember.

We have another formula, one for the power required by a moving car, which is

$$\text{H. P.} = \frac{4}{75}\, w\, m \left(\frac{c + t}{20}\right)$$

where w = the weight in net tons, m the miles per hour, c the percentage of grade expressed as a whole number, and t the traction in pounds per net ton.

As I have stated, we will assume in this formula that c equals zero, a consideration in which I am justified in express service on a road of the character I have outlined, with the relation of grades and traction given, and with the method of braking I have described. Our formula would then become, using 10 lbs. per ton as our average traction,

$$\text{H P} = \frac{2}{75}\, w\, m$$

which substituted for n in the distribution formula gives us

$$\text{C M} = \frac{1{,}008\, w\, m\ \text{L}}{\text{E}^2\ \text{S}^2}$$

or substituting for L, 5,280 d, d being the number of miles between stations,

$$\text{C M} = \frac{5{,}322{,}240\, w\, m\ \text{L}}{\text{E}^2\ \text{S}^2}.$$

We have assumed for our conductors two rods an inch in diameter, and that the rail has the same resistance. Hence, substituting for $c\ m$ its value 2,000,000, we have

$$\text{E} = \frac{2{\cdot}66112\, w\, m\, d}{\text{S}^2}$$

or

$$\text{E} = \frac{1{\cdot}631}{\text{S}} \sqrt{w\, m\, d}.$$

It will be noted that *m*, *w* and *d*, that is, number of miles per hour, weight handled, and distance over which operated, are all affected in the same way. Hence, with any value of E and S we can vary the relative values of *w*, *m* and *d* so long as we do not disturb the product. That is, we can halve the number of miles and double the speed, or double the distance and halve the running speed, keeping the weight hauled the same, and so on. For the total weight we can substitute the weight of each unit, *c*, and the number of units, *b*, thus making the formula

$$E = \frac{1{\cdot}631}{S} \sqrt{m\,b\,c\,d}.$$

For the line proposed $d = 90$, and we have

$$E = \frac{15{\cdot}56}{S} \sqrt{m\,b\,c}.$$

Taking our unit of two cars at 50 tons, the time intervals between them as 10 minutes, and 60 miles per hour as the mean speed, we have on the whole system 18 active units of two cars each, and

$$m\,b\,c = 54{,}000$$

which substituted in our formula is

$$e = \frac{3{,}616}{S}$$

which means that with one station in the middle, the potential at the motor farther from the station would be 3,616 volts, and near the station one-ninth higher. Can we handle it? Yes, in time, but perhaps not yet. Nor is there any necessity for doing so; for if we increase the number of stations and go to a 3-wire, instead of a 2-wire system, making the track the balance circuit, we would have motor potential as expressed by the following table :—

Stations.		Motor potential.	
Number.	Miles apart.	2-wire.	3-wire.
1	...	3,616	1,808
2	45	1,808	904
3	30	1,205	603
4	22½	904	452

which last brings us down to ordinary street car practice, which is only the beginning of what will be done in the effective handling of potentials.

So, after all, it does not seem such a serious electrical problem, and certainly not one to shrink from.

We can in another way illustrate the influence of the position and number of stations and the potential used. Suppose we had a station at Jersey City to supply the entire line as a certain potential over a conductor of the required size. If the station be moved to the centre, the weight of copper necessary is only one quarter. Use two stations properly spaced and the weight is quartered again. Double the potential and the weight is further quartered. Now use the 3-wire system and the weight is again quartered. So that by these very simple processes the original weight has been reduced 1·256 of the original.

I do not think I need to point out further the value of a proper determination of electrical values in a problem of this character.

We see then that the suppositious case is well within the range of possibilities. A 60-mile express service every ten minutes instead of 40 to a 45 mile service every hour, would revolutionise travel. Of the comforts of such a mode of travel I need not speak. That it will, in the not very distant future, be a fact, I know you all agree with me in hoping for.

Discussion.

Mr. Armstrong, of Camden, N.J.: I want personally to thank Mr. Sprague for one of the most interesting papers to which I ever listened. The figures that he has given us, the explanations that he has made and the statements throughout his address, have been to me of the most intense interest. I was pleased with the legal position he took. As a lawyer I must commend him as a very good lawyer. Some of the matters he has stated were novel to me in the statement of them, but he stated such general principles, that I had to say I knew it all the time, but didn't think of it.

Mr. Sprague: As to the statement of the investigation we have made, particularly into the motor power which has been used in central stations, the amount of power used, of course, depends upon the amount of traffic, the number of cars run, the schedule, the intervals between the cars, the grades. In fact, there are a great many questions which determine it. But we have very recently had an investigation made on five roads embracing every possible condition, and in a short time those will be published in detail, and the result, which will be interesting to you as central station operators, in the amount of operating power, the maximum per car, the minimum of current used. All these figures will be very exact, and they will be useful in determining the contracts which are sometimes entered into between electric railway companies and electric lighting associations.

The cost of the operation of railways is very much less than we have claimed. Whenever we have asked the railway companies to give us this cost of operating their roads they reply, "Well, when we were in the early stages of this business and it was necessary to bring us to a satisfactory condition of mind to sign a contract it was different. We find there are a great many elements of economy now we have reached there, and we would be glad if you would keep that element of economy out of sight, and do not publish it broadcast, because we do not want some legislative body to come down on us and say, 'Reduce your fares to 4 cents, or sell 7 or 8 tickets for 20 cents.'" So we have had, commercially speaking, to accede to that request.

There will be gradually in many of our cities an amalgamation of the electric light and railway interests. It seems to me that is the natural outcome, and I know that oftentimes the same stockholders are interested in both the electric light and railway companies. I am going to have very soon, in a little town in South Carolina, what I think is the most complete electrical station in the United States. Some associates and myself, being convinced that not only the electric light but the electric railway business was a good thing, from the experience we have had with it in the past two years, got hold of an electric lighting company that was earning a very reasonable dividend on its cost. The company had an electric railway franchise which was exclusive for 30 years, and which had been granted both by municipal and legislative action. It also had the general railroad privileges of condemning public and private property. The rights being exclusive not only in the two towns, but for the vicinity, for 30 years, and there being no railroad there, and there being established an electric light interest there, and there being no gas company, we thought the opportunity was an excellent one to carry out that idea which is always in the minds of electrical people, namely, the consolidating of electrical interests. We not only consolidate the electric part of it, but we consolidate the elements of management and personnel. We have different systems, the arc light system, the incandescent system, the power circuit and the railway circuit, all in the same building and under the same roof of the car sheds, and with all respect to the telephone interest, I think pretty soon we will have the telephone circuit. We are going to run telephone wires on the same poles with the others. We are going to demonstrate that it is quite possible to run a telephone circuit, an electric railway pole line not only in conjunction with it, but in conjunction with electric lights and incandescent lamps. We hope this enterprise will be profitable and that there may be a great many other places in which the same thing can be done.

Prof. Eaton of Liberty College: I would like to ask Mr. Sprague if he has any objection to stating what his principal reasons are for his conclusion that the storage battery system will not successfully compete with the overhead or direct wire system?

Mr. Sprague: It is this, the simple reason is that you cannot three times convert energy at the same economy that you can once. That is the first reason. Secondly, because you cannot carry a dead load of two tons around, unnecessarily, without energy—you cannot carry it around anyway, necessarily or otherwise, without energy. You must carry your storage battery and you cannot get rid of that useless load. It weighs nearly two tons. It weighs as much as 35 or 40 passengers. It weighs more than your motor equipment; it weighs more than your car body considered by itself; it weighs more than your iron trucks considered by themselves. We have to carry our motors around, we have to carry the trucks, the passengers, and the car bodies; but to carry our storage battery is another thing. There are no storage batteries in existence, furthermore, whose storage capacity will permit of more than 26 or 30 horse-power being taken out of it. If you limit the weight or size of your battery, you reduce its capacity. On grades of 8 per cent., and that is about the maximum which the adhesion of the rail will permit, you find a great difficulty; you will use about 30 horse-power of mechanical energy, and the motor must develop that. There is no storage battery that you can put on a 16 foot grade to-day, out of which you can take that power for 30 minutes at a time; the capacity is not there. But when you get the overhead line or the underground conductor, provided it is connected with a big engine and a lot of dynamos at the other end, you can demand from that station all your motor can carry. There is no storage battery which a company dare recommend for operation upon a 6 per cent. grade, or that you could run 160, 170, or 180 miles a day. The maximum work of a storage battery per car, per day, is about 80 or possibly 90 miles, and there are very few cars doing that. There are no storage battery cars in the United States that I am aware of, that are working 18, 19, or 20 hours a day, as is the case with the direct system of supply.

I hope, as cordially as any other man can, that the storage battery is going to be a success, but there is no question that its limitations are pretty clearly fixed and that it can never compete with direct sources of supply in capacity. There is no limit to the capacity of the motor or the amount of current you can use from a direct source of supply. There is certainly a well defined narrow limit in the case of the storage battery. I say that with all friendliness to the storage battery, because I am interested financially in one—or rather I should say one is financially interested in me.

Connecting or Disconnecting Electric Circuits.—We omitted to state in our last issue, March 21st, page 317, with reference to the description and drawings of Mr. S. B. McLellan's newly patented relay and continuous action bell, that Messrs. Price, Talbot & Co., of 26, Ludgate Hill, London, E.C., are the sole agents and manufacturers.

PROCEEDINGS OF SOCIETIES.

Institution of Electrical Engineers, February 27th, 1890.

Discussion on Mr. Swinburne's paper "The Theory of Armature Reaction in Dynamos and Motors," and on Mr. Esson's paper, "Some Points in Dynamo and Motor Design."

(*Authorised Abstract.*)

Before the commencement of the discussion proper, Mr. ESSON made a few remarks on the construction of the armature cores in the machines used as dynamos and motors. The Gramme and Pacinotti, he said, were built up of thin discs, whilst the Burgin had wire cores carried by six armed spiders. He thought the great difference between the E.M.F. of the latter when used as dynamo and motor might be due to the iron wires having been brought into electric contact by forcing the spiders in the rings and thus causing parasitic currents. He also corrected an error made in stating Mr. Ravenshaw's rule where, instead of the ampère-turns being 24 and 48 times the area of the field magnets, 35 and 70 times the area of the armature core should be substitued. With reference to this rule, Mr. Esson said, if it were true, then by doubling the length of an armature the load might be doubled without giving rise to sparking. In his opinion the ampère-turns should remain the same. Again, Mr. Ravenshaw's rule would, when applied to similar machines give the ampère-turns on armature proportional to the square of radial depth of core, whereas this was shown to be proportional to the first power of the depth.

Prof. AYRTON said he was particularly interested in Mr. Esson's paper, because it contained so many experimental results. Referring to Mr. Swinburne's method of treating the subject he deprecated the use of the term "magnetic potential," where difference of magnetic potential was meant. He also thought Mr. Esson's term "working saturation," was not to be recommended, and that "working induction" would be much better. In his further remarks the Professor said he would confine himself chiefly to three heads, which were brought out prominently in a paper on "Electromotors," by Prof. Perry and himself, in 1883, and about which considerable difference of opinion still existed. There were, 1st, the existence of magnetic lag; 2nd, the alteration of resistance of revolving armatures by self-induction; and 3rd, motor construction for minimum weight. As regards magnetic lag, this, he said, had often been denied, but quite recently, Prof. Ewing had shown that such lag did occur, amounting in some cases to several minutes. With reference to the increased resistance of revolving armatures due to self-induction, he thought some misunderstanding existed, for Mr. Swinburne in his paper says that "power cannot be lost by self-induction." In their original paper, Prof. Perry and himself had given a formula for calculating this loss when the brushes were placed at the neutral position, and this they confirmed experimentally. When, however, this condition is not fulfilled a modification is necessary. If the brushes could be placed at an absolutely non-sparking position the resistance of the armature would not be increased by rotation, for then a section leaves the brush and is thrown into circuit with the proper current in it and hence no further E.M.F. is needed to bring the current up to its proper value. In fact the energy used in starting the current is supplied by the belt whilst the coil is short-circuited. He also said that in a dynamo with sparkless lead, the coils between the neutral line and the brushes acted as motor coils and assisted the rotation of the armature, whereas in a motor they act as dynamo coils and oppose the rotation.

Before passing to the third heading reference was made to some remarks of Mr. Esson in the discussion on Mr. A. T. Snell's paper of "Design of Motors," read before the City Guilds' Old Students Association last year. Mr. Esson there said that the chief use of the series winding in compounded Manchester dynamos was to counteract the demagnetising action of the armature. To test this, experiments had been made on such a machine and it was found that out of 10,560 ampère-turns required at full load 2,660 were required to compensate for back induction, and 2,100 for loss due to resistance of armature. Commenting on the best relation of iron to copper in armatures Prof. Ayrton thought it a mistake to assume constant induction in the armature, for an increase of copper would mean greater excitation. Taking the excitation as fixed, Prof. Perry and himself had shown (Pro. Phys. Soc., Vol. IX., p. 220) that maximum output was obtained when the magnetic resistance of the space occupied by copper was equal to that of the rest of the circuit. As regards the question whether motors should or should not be made different from dynamos, the speaker said that in an Immisch series motor run as a dynamo and as motor at the same speed and current the E.M.F. (neglecting self-induction) was 14 per cent. greater as a motor, and when the maximum possible effect of self induction was allowed, a difference of 10 per cent. still remained. This had since been confirmed by measuring the induction in the field magnets, both when a current was sent through the magnet coils alone and then through both magnets and armature, the latter revolving at 1,400 revolutions as a motor. In the latter case the induction was 5 per cent. greater than in the former. Experiments on the characteristics of a magneto Gramme used as a generator and as a motor with equal lead and trail, show that as a dynamo the curve falls, as in Fig. 15 of Mr. Esson's paper, whereas as a motor the curve rises with increase of current. On trying the same experiments with a separately excited A Gramme the E.M.F. as a motor always increased with the current through the armature, whatever the strength of exciting current used, but as a generator the E.M.F. always decreased, and with a weak field became negative when the armature current increased. In conclusion, Prof. Ayrton contended that the above experiments, as well as those of Mr. Esson on the Bürgin machine, proved conclusively that a relatively powerful armature strengthens the field of a motor and weakens that of a dynamo.

Mr. RAVENSHAW said that apart from their own merits Mr. Swinburne's and Mr. Esson's papers would be most useful in promoting discussion on the causes of sparking. As regards Mr. Esson's expression for the ampère-turns, which may be carried on an armature, he could not say that it held good in practice. He himself had experimented a good deal on the subject, and the results seemed to point to the fact that for all sizes and shapes of well designed machines, their behaviour at the brushes would be very similar when the ratio between the ampère-turns and the total induction in the armature was the same. This he gave, not as a law, but as a result of his own experience. This experience, however, did not agree with that of Mr. Esson.

One machine, made for 4,000 watts, on which he had made many experiments had a very small distance between the pole pieces and armature core, and the pole pieces were rather close together. After testing it under these conditions up to 6,000 or 7,000 watts, he tried it with the field bored much larger, and also with the poles cut off until they embraced an angle of 90°. Under all these conditions the maximum ampère-turns it would carry without sparking appeared to be the same, the armature induction being kept constant. This machine was afterwards wound with a drum armature, and he had built two other types of machines with the same area of armature core, both of which carried the same ampère-turns.

	Dynamo.	Kilowatts.	Mr. Esson's Coefficient.	$\frac{\text{Ampère-turns}}{\text{armature core area.}}$	Armature.
1	4 pole	16	40,000	31	Gramme
2	Under type	16	50,000	32·5	
3	Gramme field	16	70,000	28·5	
4	Under type	6·5	36,000	72	Drum
5	Over type	6·5	62,000	67	
6	Over type	6·5	73,000	64	
7	Over type	46	151,000	61	
8	Over type	46	220,000	60	

The above table shows Mr. Esson's coefficient for these three machines. According to Mr. Esson, No. 4 should have carried double the ampère-turns on No. 6; but, as a matter of fact, No. 6 sparked decidedly the least. No. 8 was built when copper was very expensive, and was in all *other* respects the same as No. 7, excepting that it had a large armature, large polar surface, and a very short air space. Both machines were sparkless, but began to spark at about 50 per cent. above full load. No. 1, 2, and 3 were of entirely different design, agreeing only in the area of the armature core. They all behaved in exactly the same way at the brushes when working with the same number of ampère-turns on the armature, All the eight machines sparked a good deal with 50 per cent. more load than that given in the table. Mr. Esson had said that if the length of the armature was increased, the ampère-turns must be kept constant. In reply to this, Mr. Ravenshaw said he built all his machines in sets of three, the only difference between the largest and smallest of each set being in the length of the armature and magnet cores, and the ampère-turns on the armature were increased in the same proportion. In Gramme armatures the output was limited by sparking, but with drums it was limited by heating, for the ampère turns which cauld be carried by the latter were at least double those of the former. Speaking of magnetic leakage, Mr. Ravenshaw said most engineers seemed to think it impossible to calculate it with certainty; but this was erroneous, for he had been in the habit of calculating the leakage from the drawings for some years past, and always obtained accurate results. This is important, as he finds that the leakage may be as high as 45 per cent., and as low as 20 per cent.

Mr. KAPP stated that the two papers under discussion would form very important landmarks in the development of the dynamo, and said the subjects treated in them had been brought into prominence by the use of large machines. According to Mr. Swinburne, the limiting diameter of armatures in two-pole machines was about 40 centimetres, but he (Mr. Kapp) had, by increasing the dimensions of all the parts proportionately, made dynamos with 50 cm. armatures, and others had gone still higher. Referring to formula (2) in Mr. Swinburne's paper, he asked whether the coefficient, M, was correct, for, as given, the length of the armature was not taken into account. His own experience gave coefficients varying from 0·12 to 0·18, instead of from 0·08 to 0·085. He also found that the magnetic leakage resistance in English measure for two-pole dynamos of the upright type was expressed by the formula $\frac{680}{\sqrt{l\,d}}$, and for the inverted type by $\frac{460}{\sqrt{e\,d}}$, where l and d are the length and diameter of the armature in inches. As regards reversing pole pieces he said that they were brought out about five years ago by Mather. Coming to Mr. Esson's paper, Mr. Kapp wished to add one device for equalising the field in single magnet machines, which had been omitted from the interesting collection given This device consists in making the upper horns, *b*, fig. 7, rather longer than the lower ones. As regards the ratio of armature to field section, he thought the remarks made were only applicable to badly designed machines, for in good dynamos there was no room for such radical changes. The agreement of Mr. Esson's coefficients in Table II., he said, was rather surprising at first sight, but on examining the formula it may be seen to be equivalent to saying that the maximum ampère-turns on an armature may be proportional to the ampère-turns on the field magnets required to produce a given induction in the armature, a not unnatural conclusion. His own opinion was that both Mr. Esson and Mr. Ravenswaw loaded the machines too heavily. As a rough rule he found that the expression ampère-turns on armature = 1,000 ($d - 5$), where d is the diameter in inches agreed, vary well with his practice. He cordially endorsed Mr. Esson's remarks on the small rise of temperature allowed by the Admiralty, for a rise 11° C. meant enormous machines for their output. On the other hand, he usually allowed more cooling surface than Mr. Esson, his rule being 1·5 and 2·5 square inches per watt wasted in armature and magnets respectively. Referring to the relation between size and output, Mr. Kapp thought the exponent $2\frac{1}{4}$ given by Mr. Esson was rather low, for from actual tests on machines with armatures varying from 7 to 13 inches in diameter he found that for Gramme winding the output varied from $d^{3\cdot3}$ to $d^{3\cdot7}$, and for drums from $d^{3\cdot3}$ to $d^{3\cdot9}$.

Mr. **Farquharson** said he thought the Admiralty rule for limiting rise of temperature had been misunderstood, and in Mr. Esson's paper it was wrongly stated, for the rise permitted was 30° F., and not 11° C. The method of testing adopted by the Admiralty was to take the temperature outside the insulation immediately the machine was stopped. This temperature was by no means the same as that within the conductor, for he had known the outside temperature to rise for 20 minutes after the machine was stopped. Keeping this fact in view, together with the long continuous runs (sometimes amounting to 24 days and nights), to which ship lighting dynamos may be subjected, he thought the Admiralty were justified in fixing the limiting temperature low enough to be safe for all machines. As a proof that the rule was not impracticable he mentioned that all of 12 machines, already delivered this year, were well within the limit allowed.

Mr. A. T. **Snell**, speaking of machines run as dynamos and as motors, said he always found it possible to get a greater output at a given speed when running as a motor, and that the trail as a motor was always less than the lead as a dynamo. In fact, with motors used for tramcars they worked without lead, and run in either direction with the same pair of brushes. Another point, in which motors differed from dynamos, was the possibility of using very thick brushes with advantage in the former, whereas in the latter such a proceeding proved disastrous. These differences seemed to him to show that the magnetic distribution in generators and motors are not the same, and that in dynamos the field was more straggling and subject to greater distortion. Referring to Mr. Esson's formulæ for the loading of armatures, Mr. Snell said he had tested it on machines with which he was acquainted, and, although he found a certain agreement, this was by no means so close as the numbers given in the paper. He himself had been in the habit of using the formula:

$$\text{Electrical horse-power} = l\, d^2\, n\, k,$$

where l and d are the length and diameter of the armature, n the speed, and k a constant; and this gave close approximations where the armatures have the same proportions. Alluding to rise of temperature in large machines after long runs, he mentioned that in some machines designed to work between 50 and 100 H.P. this amounted to 50° F., the temperature being taken on the wire on the inside of the cylinder armatures.

The discussion was then adjourned to the 13th of March.

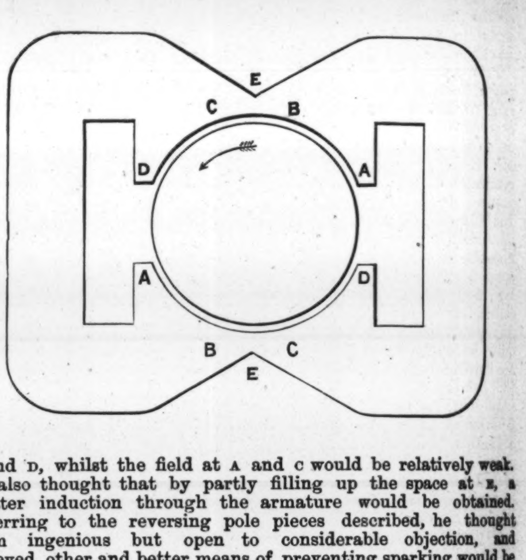
MARCH 13th.

Adjourned discussion on Mr. Swinburne's and Mr. Esson's papers. (Authorised abstract.)

Prof. **Ayrton** exhibited curves representing results of experiments on the Gramme magneto and Gramme dynamo when run as motors and generators, which he described on the 27th ult. Another curve showed similar results obtained with a Manchester dynamo separately excited with half its normal current. In this machine, run as a generator with a lead of 11°, the E.M.F. decreases with increase of current in the armature, whereas when run as a motor with a trail of 11° the E.M.F. rises under the same conditions. From these observations he concluded that Mr. Swinburne and Mr. Esson were wrong in saying that the back E.M.F. in a motor could not be greater than the forward E.M.F. in a dynamo working under the same conditions as to speed and current. The secret of obtaining this increased E.M.F. in motors was, he believed, the employment of a relatively powerful armature.

Mr. **Willans**, referring to Mr. Esson's remarks relating to the magnetic pull on armatures of single magnet machines, said the inverted type described (fig. 5) was the worst that could be adopted, for by employing those of the upright type (fig. 9) the magnetic pull could be caused to support the weight of the armature and the supposed defect converted into a distinct advantage. Speaking of the Admiralty temperature limit, criticised by Mr. Esson and Mr. Kapp, he said that in testing the combined efficiency of engines and direct-driven dynamos they had, with machines that run cool, obtained 84 or 85 per cent. of the indicated horse power available at the dynamo terminals. On the other hand, machines that get hot never yielded more than 70 per cent. Whilst agreeing with the Admiralty that the rise of temperature allowable should be small, he objected to the method of taking the temperature; this method he characterised as being more a test of the heat conductivity of the insulation and thermometer than of the temperature of the machine.

Prof. **Forbes** said that both authors had touched upon very important points which had not been previously discussed in public. As regards Mr. Swinburne's paper, he said non-mathematical readers should not accept unreservedly all the conclusions there arrived at, for some of them are admittedly based on approximations and assumptions which are not always fulfilled in practice. Nevertheless, he considered the treatment a step in the right direction. He could not accept Mr. Swinburne's statement that self-induction *prevents* waste of power, for all sparking is due to self-induction, and consequently it *causes* a waste of power. Another point about which he had grave doubts was the efficacy of the method of throttling cross induction shown in figs. 3 and 4. His own (Prof. Forbes's) opinion was that such methods would tend to concentrate the lines about B and D, whilst the field at A and C would be relatively weak. He also thought that by partly filling up the space at E, a greater induction through the armature would be obtained. Referring to the reversing pole pieces described, he thought them ingenious but open to considerable objection, and believed other and better means of preventing sparking would be devised. Coming to Mr. Esson's paper, he said the remarks respecting the utility and accuracy of calculating the waste field, were directly opposed to his own opinion on the subject, and also to the experience of Mr. Ravenshaw. This point, he thought, gave a good instance of how some self-designated "practical men" object to spend the few hours necessary to calculate the waste field, and prefer spending a month's labour in making a machine with all its attendant expense, in order to obtain experimentally results which could have been readily derived by calculation. Prof. Forbes congratulated Mr. Esson on the many experimental results given in his paper and on the valuable and interesting way in which he had treated the subject of loss by hysteresis illustrated by fig. 14, and the distortion of the field produced by the armature current. His own experience with non-commutating dynamos had brought the latter phenomenon prominently before him, for he had found the E.M.E. at full load to be about half it value at no load. This he attributed to the fact that a given demagnetising force produces a much greater change of induction than that produced by an equal magnetising force when the iron is not saturated. Referring to the loads carried by armatures, he considered that the limit should not be fixed by sparking, but rather by questions of heating and efficiency. Armatures designed on the latter lines should then be examined by the light of Mr. Esson's formula, and if they do not satisfy the non-sparking condition, must be modified accordingly.



Mr. **Mordey** regretted that Mr. Swinburne's paper was not printed so fully as it was read. He did not agree with Prof. Forbes as to the result of reducing cross induction by the methods shown in figs. 3 and 4 of Mr. Swinburne's paper; in fact, he considered the plan quite natural and it was very effective in well designed machines. He thought that subsidiary or reversing pole pieces would not be practical and that sparking is generally due to overloading; a better plan of preventing sparking would be to utilise the additional length of armature which the pole pieces require, for lengthening the main core, thereby reducing overloading.

Mr. **Swinburne** here pointed out that the devices were not merely to prevent sparking, but to reduce the back-turns, thus diminishing or rendering unneccessary the series windings on machines for constant E.M.F.

Mr. **Mordey** (continuing) referred to "small air space dynamos" and said Mr. Swinburne was once a great advocate of such machines as well as of "large output dynamos." However, as far as he was aware, no great progress had been made with either variety, for makers seem to have come back to machines having moderate air spaces and of moderate output. Speaking of "high tension constant current dynamos," he said many difficulties were met with in smooth commutator machines under varying load. The Brush machine had been tried shunt wound, but it would not excite at small loads, and at large loads it flashed round. The supposition as to the cause of excessive heating of the trailing horn given on slip 13 was not satisfactory, for the same corner heats if the machine be run as a motor, only not quite so much. The effect is probably due to the magnetic tufts from the Pacinotti projections. In discussing methods of measuring temperature of machines, he said this was sometimes done by measuring the resistance of the armature when hot; but this was not to be relied upon, for owing to expansion and consequent change of contact resistance at the soldered joints, the resistance hot might be less than when cold. Referring to Prof. Ayrton's remarks on the construction of "light-weight motors," Mr. Mordey said such machines were like "large output" dynamos, in not being successful in practice. He then read abstracts from Profs. Ayrton and Perry's paper on "Electro-motors, &c.," which, in his opinion, had retarded rather than advanced motor design. He contended that, both in dynamos and motors, an armature which produces no appreciable field is the best. As regards "magnetic lag," he said that any such lag of practical importance would prevent E.M.F. being proportional to speed. Experiments on a Victoria Brush machine showed that from 200 to 1,200 revolutions per minute the E.M.F. curve was a straight line, in spite of eddy currents, which increase as the square of the speed.

Prof. Ayrton here remarked that Dr. Thompson, who agrees with Mr. Mordey as to the non-existence of magnetic lag, entirely disagrees with him on the question of E.M.F. being proportional to speed.

Mr. Mordey, in reply, said he was not answerable for Dr. Thompson's statements; but he was quite sure that in well-made machines he had tested the E.M.F. was exactly proportional to speed.

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The discussion was then adjourned to the 20th inst..

(To be continued.)

CORRESPONDENCE.

Telephonic Specific Inductive Capacity.

I beg permission to make a few remarks on the paper under the above title published in your last issue.

Dr. Jacques's conclusions, as quoted at the head of the paper, lack intelligibility by the absence of units of measurement. Dr. Jacques was not alone in formulating the doctrine quoted. Mr. Preece and Dr. Wietlisbach were in the same field, whether anticipatory or not is unimportant. For convenient reference, I may remark that Mr. Preece's views will be found in "The Telephone" (Preece and Maier), p. 122, &c. All agree on the importance of the factors quoted from Dr. Jacques, though, when reduced to figures, their conclusions differ. That, however, is a point of no importance here.

Messrs. P. H. Safford and G. U. G. Holman state in their paper, that they "made an accurate series of measurements of the specific inductive capacity of the following substances when submitted to actual telephone currents," and the following results amongst others are given:—"Solid paraffin 2·0; cotton saturated with paraffin in vacuum (Faraday cable) 2·0; cotton boiled in paraffin *(Patterson cable)* 2·6; water 6.3."

I do not impugn the accuracy of these figures as applied to the substances, nor do I confirm them. They may or may not be correct. What I do object to is the inclusion of the words which I have quoted in italics. Scientific and technical accuracy require their omission. Cotton boiled in paraffin is not Patterson cable, nor a correct description of its insulating substance.

Further on we have the following in greater detail:—

"If the wires are wound with cotton, and then boiled in paraffin, *as they are in making Patterson cables*, the specific inductive capacity is raised to 2·6, an increase of 30 per cent., which we have seen, is a very great detriment."

Again does scientific and technical accuracy require the omission from the paper of the words quoted in italics.

When they are so omitted, the whole edifice which has been so laboriously raised tumbles down, as I will endeavour to show.

The elements of the Patterson cable may or may not be generally known, but scientific investigators, writing directly upon the subject, might at least be expected to be familiar with them. The information is not difficult to obtain. It may be found in the Patent Offices of the United States and the United Kingdom. It has been published in trade catalogues, to my knowledge, since 1883, and was probably earlier. A brief notice of the cable appeared in your columns on January 17th, 1885 (Vol. XVI., p. 46), from which I extract the following:—

"Another, and not less important feature of the process (of filling), is *to reduce the specific inductive capacity of the insulating material at least* 15 *per cent.*" I need not occupy your space by saying why this is so. The evidence is, of course, *ex parte*. I shall be happy to prove it if called in question.

The insulating material mentioned is paraffin. The figure given in the table for solid paraffin is 2·0. It is reasonably near standard authorities, otherwise I should have some hesitation in adopting it, even for were brought out about five years ago by Mather. Coming to Mr. Esson's paper, Mr. Kapp wished to add one device for equalising the field in single magnet machines, which had been omitted from the interesting collection given This device consists in making the upper horns, *b*, fig. 7, rather longer than the lower ones. As regards the ratio of armature to field section, he thought the remarks made were only applicable to badly designed machines, for in good dynamos there was no room for such radical changes. The agreement of Mr. Esson's coefficients in Table II., he said, was rather surprising at first sight, but on examining the formula it may be seen to be equivalent to saying that the maximum ampère-turns on an armature may be proportional to the ampère-turns on the field magnets required to produce a given induction in the armature, a not unnatural conclusion. His own opinion was that both Mr. Esson and Mr. Ravenswaw loaded the machines too heavily. As a rough rule he found that the expression ampère-turns on armature $= 1{,}000\ (d - 5)$, where d is the diameter in inches agreed, vary well with his practice. He cordially endorsed Mr. Esson's remarks on the small rise of temperature allowed by the Admiralty, for a rise 11° C. meant enormous machines for their output. On the other hand, he usually allowed more cooling surface than Mr. Esson, his rule being 1·5 and 2·5 square inches per watt wasted in armature and magnets respectively. Referring to the relation between size and output, Mr. Kapp thought the exponent 2½ given by Mr. Esson was rather low, for from actual tests on machines with armatures varying from 7 to 13 inches in diameter he found that for Gramme winding the output varied from $d^{3\cdot3}$ to $d^{3\cdot7}$, and for drums from $d^{3\cdot3}$ to $d^{3\cdot9}$.

Mr. FARQUHARSON said he thought the Admiralty rule for limiting rise of temperature had been misunderstood, and in Mr. Esson's paper it was wrongly stated, for the rise permitted was 30° F., and not 11° C. The method of testing adopted by the Admiralty was to take the temperature outside the insulation immediately the machine was stopped. This temperature was by no means the same as that within the conductor, for he had known the outside temperature to rise for 20 minutes after the machine was stopped. Keeping this fact in view, together with the long continuous runs (sometimes amounting to 24 days and nights), to which ship lighting dynamos may be subjected, he thought the Admiralty were justified in fixing the limiting temperature low enough to be safe for all machines. As a proof that the rule was not impracticable he mentioned that all of 12 machines, already delivered this year, were well within the limit allowed.

Mr. A. T. SNELL, speaking of machines run as dynamos and as motors, said he always found it possible to get a greater output at a given speed when running as a motor, and that the trail as a motor was always less than the lead as a dynamo. In fact, with motors used for tramcars they worked without lead, and run in either direction with the same pair of brushes. Another point, in which motors differed from dynamos, was the possibility of using very thick brushes with advantage in the former, whereas in the latter such a proceeding proved disastrous. These differences seemed to him to show that the magnetic distribution in generators and motors are not the same, and that in dynamos the field was more straggling and subject to greater distortion. Referring to Mr. Esson's formulæ for the loading of armatures, Mr. Snell said he had tested it on machines with which he was acquainted, and, although he found a certain agreement, this was by no means so close as the numbers given in the paper. He himself had been in the habit of using the formula:

$$\text{Electrical horse-power} = l\, d^2\, n\, k,$$

where l and d are the length and diameter of the armature, n the speed, and k a constant; and this gave close approximations where the armatures have the same proportions. Alluding to rise of temperature in large machines after long runs, he mentioned that in some machines designed to work between 50 and 100 H.P. this amounted to 50° F., the temperature being taken on the wire on the inside of the cylinder armatures.

The discussion was then adjourned to the 13th of March.

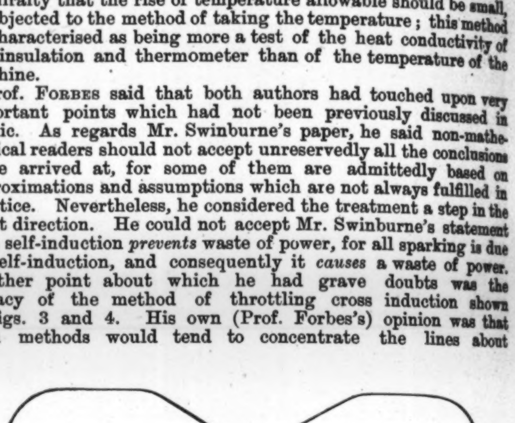
MARCH 13th.

Adjourned discussion on Mr. Swinburne's and Mr. Esson's papers. (Authorised abstract.)

Prof. AYRTON exhibited curves representing results of experiments on the Gramme magneto and Gramme dynamo when run as motors and generators, which he described on the 27th ult. Another curve showed similar results obtained with a Manchester dynamo separately excited with half its normal current. In this machine, run as a generator with a lead of 11°, the E.M.F. decreases with increase of current in the armature, whereas when run as a motor with a trail of 11° the E.M.F. rises under the same conditions. From these observations he concluded that Mr. Swinburne and Mr. Esson were wrong in saying that the back E.M.F. in a motor could not be greater than the forward E.M.F. in a dynamo working under the same conditions as to speed and current. The secret of obtaining this increased E.M.F. in motors was, he believed, the employment of a relatively powerful armature.

Mr. WILLANS, referring to Mr. Esson's remarks relating to the magnetic pull on armatures of single magnet machines, said the inverted type described (fig. 5) was the worst that could be adopted, for by employing those of the upright type (fig. 9) the magnetic pull could be caused to support the weight of the armature and the supposed defect converted into a distinct advantage. Speaking of the Admiralty temperature limit, criticised by Mr. Esson and Mr. Kapp, he said that in testing the combined efficiency of engines and direct-driven dynamos they had, with machines that run cool, obtained 84 or 85 per cent. of the indicated horse power available at the dynamo terminals. On the other hand, machines that get hot never yielded more than 70 per cent. Whilst agreeing with the Admiralty that the rise of temperature allowable should be small, he objected to the method of taking the temperature; this method he characterised as being more a test of the heat conductivity of the insulation and thermometer than of the temperature of the machine.

Prof. FORBES said that both authors had touched upon very important points which had not been previously discussed in public. As regards Mr. Swinburne's paper, he said non-mathematical readers should not accept unreservedly all the conclusions there arrived at, for some of them are admittedly based on approximations and assumptions which are not always fulfilled in practice. Nevertheless, he considered the treatment a step in the right direction. He could not accept Mr. Swinburne's statement that self-induction *prevents* waste of power, for all sparking is due to self-induction, and consequently it *causes* a waste of power. Another point about which he had grave doubts was the efficacy of the method of throttling cross induction shown in figs. 3 and 4. His own (Prof. Forbes's) opinion was that such methods would tend to concentrate the lines about B and D, whilst the field at A and C would be relatively weak. He also thought that by partly filling up the space at E, a greater induction through the armature would be obtained. Referring to the reversing pole pieces described, he thought them ingenious but open to considerable objection, and believed other and better means of preventing sparking would be devised. Coming to Mr. Esson's paper, he said the remarks respecting the utility and accuracy of calculating the waste field, were directly opposed to his own opinion on the subject, and also to the experience of Mr. Ravenshaw. This point, he thought, gave a good instance of how some self-designated "practical men" object to spend the few hours necessary to calculate the waste field, and prefer spending a month's labour in making a machine with all its attendant expense, in order to obtain experimentally results which could have been readily derived by calculation. Prof. Forbes congratulated Mr. Esson on the many experimental results given in his paper and on the valuable and interesting way in which he had treated the subject of loss by hysteresis illustrated by fig. 14, and the distortion of the field produced by the armature current. His own experience with non-commutating dynamos had brought the latter phenomenon prominently before him, for he had found the E.M.E. at full load to be about half it value at no load. This he attributed to the fact that a given demagnetising force produces a much greater change of induction than that produced by an equal magnetising force when the iron is not saturated. Referring to the loads carried by armatures, he considered that the limit should not be fixed by sparking, but rather by questions of heating and efficiency. Armatures designed on the latter lines should then be examined by the light of Mr. Esson's formula, and if they do not satisfy the non-sparking condition, must be modified accordingly.



Mr. MORDEY regretted that Mr. Swinburne's paper was not printed so fully as it was read. He did not agree with Prof. Forbes as to the result of reducing cross induction by the methods shown in figs. 3 and 4 of Mr. Swinburne's paper; in fact, he considered the plan quite natural and it was very effective in well designed machines. He thought that subsidiary or reversing pole pieces would not be practical and that sparking is generally due to overloading; a better plan of preventing sparking would be to utilise the additional length of armature which the pole pieces require, for lengthening the main core, thereby reducing overloading.

Mr. SWINBURNE here pointed out that the devices were not merely to prevent sparking, but to reduce the back-turns, thus diminishing or rendering unneccessary the series windings on machines for constant E.M.F.

Mr. MORDEY (continuing) referred to "small air space dynamos" and said Mr. Swinburne was once a great advocate of such machines as well as of "large output dynamos." However, as far as he was aware, no great progress had been made with either variety, for makers seem to have come back to machines having moderate air spaces and of moderate output. Speaking of "high tension constant current dynamos," he said many difficulties were met with in smooth commutator machines under varying load. The Brush machine had been tried shunt wound, but it would not excite at small loads, and at large loads it flashed round. The supposition as to the cause of excessive heating of the trailing horn given on slip 13 was not satisfactory, for the same corner heats if the machine be run as a motor, only not quite so much. The effect is probably due to the magnetic tufts from the Pacinotti projections. In discussing methods of measuring temperature of machines, he said this was sometimes done by measuring the resistance of the armature when hot; but this was not to be relied upon, for owing to expansion and consequent change of contact resistance at the soldered joints, the resistance hot might be less than when cold. Referring to Prof. Ayrton's remarks on the construction of "light-weight motors," Mr. Mordey said such machines were like "large output" dynamos, in not being successful in practice. He then read abstracts from Profs. Ayrton and Perry's paper on "Electro-motors, &c.," which, in his opinion, had retarded rather than advanced motor design. He contended that, both in dynamos and motors, an armature which produces no appreciable field is the best. As regards "magnetic lag," he said that any such lag of practical importance would prevent E.M.F. being proportional to speed. Experiments on a Victoria Brush machine showed that from 200 to 1,200 revolutions per minute the E.M.F. curve was a straight line, in spite of eddy currents, which increase as the square of the speed.

Prof. AYRTON here remarked that Dr. Thompson, who agrees with Mr. Mordey as to the non-existence of magnetic lag, entirely disagrees with him on the question of E.M.F. being proportional to speed.

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"Another, and not less important feature of the process (of filling), is *to reduce the specific inductive capacity of the insulating material at least* 15 *per cent.*" I need not occupy your space by saying why this is so. The evidence is, of course, *ex parte*. I shall be happy to prove it if called in question.

The insulating material mentioned is paraffin. The figure given in the table for solid paraffin is 2·0. It is reasonably near standard authorities, otherwise I should have some hesitation in adopting it, even for argument. Let me assume it to be correct, and let me also assume the correctness of the claim that the Patterson process reduces it by 15 per cent., and we have the capacity of the insulating material or materials, substance or substances of Patterson cable as 1·7 instead of 2·6 !!!

Later in the paper we have a description of the Faraday cable, and then the following statement :—

"It is possible that the inferiority of the Patterson cable, as compared with the Faraday, is due largely to the moisture retained in the cotton which we have seen has a capacity of 6·3."

It will be observed that there is no question about this "inferiority." The casual listener or reader might well assume that it was clearly demonstrated by actual experience or was a matter of everyday knowledge. But on what is it based ? How is it arrived at ? By taking some "cotton boiled in paraffin," and labelling it "Patterson cable," testing it and giving it a value ; by dropping the words "cotton boiled in paraffin," and substituting therefor the words "Patterson cable," with which it was labelled.

In the Patterson cable there is, of course, no "moisture retained in the cotton." Enquiry as to the process of manufacture would have shown the investigators that such is the case if they desired such knowledge. That moisture was retained in the cotton which they used for experiment is likely, since no mention is made of any precautions being taken to get it dry and keep it dry.

Had the words "Patterson Cable" been omitted from the table, as they should have been, the paragraph would have read—and similarly throughout the paper —"the inferiority of the sample of cotton boiled in paraffin as compared with the sample of cotton saturated with paraffin in vacuum," &c., &c. This might have been accurate, it would have been unobjectionable, and it would certainly have saved me inflicting upon you this letter. But would it have enabled the authors to accomplish the purpose the paper was apparently designed to serve ?

In a paper so prevalent of errors on the one side, it is unlikely there is an entire freedom from errors on the other, but the general drift of the paper justifies me in assuming that the best case has been made out for the Faraday cable. Possibly it suffers from the inaccuracies of its friends, like the rest, but according to the paper, "we have seen" that the capacity of its insulating substance is equal to solid paraffin, *i.e.*, 2·0. Again, I do not assume the correctness of this figure, but will take it for purposes of argument, and following the example of the authors in making comparisons, I get Patterson 1·7., Faraday 2·0, which is clearly proof of the "inferiority" of the Patterson !!!

It is much to be preferred that a scientific paper should be criticised by a scientific and independent writer ; but if I am not much mistaken, the paper in question is far more of a commercial production than a scientific one, and it is, therefore, not so much out of place for me to criticise it.

It is self-evident that the object of the paper was to advertise the supposed merits of a cable sailing under the honoured name of Faraday, and the supposed defects of other cables legitimately christened by the names of their inventors ; and how are these objects attained ? By adopting entirely erroneous standards, and ingeniously misleading methods. The paper is simply a re-hash of well-known material as a framework for such an advertisement. So far as I am aware, the only element of newness about it is the statement that to measure capacity for telephone currents some new-fashioned methods are necessary—and what is the result ? The capacity of paraffin, which forms the groundwork of the paper, is almost identical with that of established authorities, who, presumably, adopted old-fashioned methods ; gutta-percha is exactly the same ; rubber is higher (it has doubtless sufficient elasticity to recover the shock) ; water I cannot compare, as I do not find it in available references. It is unimportant whether it be 6·3 or 66·3, and was apparently only introduced in the table for the purpose of forming the foundation of one of the false premises I have endeavoured to expose.

I think I am justified in protesting against such a paper being prepared and published to mislead learned societies, technical papers, and their readers.

The paper has dragged in the name of the Patterson cable in comparison with the Faraday. The Patterson cable is made by the company which I represent here (though I must take individually the responsibility of this letter). Who are the makers of the Faraday ? and who is responsible for the production and dissemination of such a paper ? For two students of a technical institute we may find some excuses on the score of ignorance, though their capacity for specific and inductive misstatement is apparently high. If the Mr. W. W. Jacques who stood sponsor for the paper by presenting it to the Academy is the same as the Dr. Jacques quoted, it would be uncourteous to suggest the same ground of excuse for him.

Does the responsibility lie beyond these sources ?

I must apologise for the length and tone of this letter. The paper was, happily, exceptional, and necessitates exceptional treatment.

J. E. Kingsbury.

Western Electric Company,
79, Coleman Street, E.C.,
March 25th, 1890.

Definitions of Physical Terms.

From a paragraph in your last week's issue it appears that my definitions of physical terms, as conveyed in the articles in *Glasgow Herald*, do not meet with your approval. Of course it is a very easy task to criticise anything ever written, and probably that which offers the easiest task for the critic is an article on a technical subject in which an endeavour has been made to treat it "popularly." You can even find inaccurate statements of the kind you refer to in the popular lectures delivered by our most distinguished scientists. These inaccuracies arise not so much from ignorance of the correct definitions as from the extreme difficulty of putting in easily readable form, within reasonable limit and, in my case, within a short period of time, such information as will enable non-technical people to grasp the leading facts. I aimed at nothing more, and my articles have been taken in that light and have obtained praise from quarters to which I never looked for it. Had I been writing for the REVIEW I should of course have given the definitions you have over and over again fought for in your journal.

David Cook.

March 24th, 1890.

Far Distance Dynamo.

I am obliged for Messrs. Bolling & Lowe's expanded description of their double dynamo arrangement (which, however, I fully understood from their first letter, and admitted could clearly be made to do what was wanted), but regret that they have entirely ignored the question that I asked, and, with your permission, that I will now repeat. What special effect is produced on the main circuit by having the series coils on the field magnets of F. D. placed on a supplementary dynamo instead of on the main dynamo ? For instance, if one compound dynamo alone is used, wound so as to give at its terminals with normal speed the constant E.M.F. of 110 volts, as supposed in Messrs. Bolling and Lowe's last letter, and enough series turns are added to its field coils to produce, when a current of 50 ampères is flowing, a total E.M.F. of 115 volts, what is to prevent this pressure from being increased to 120 volts when the current is 100 ampères, and so on in proportion ?

I certainly was under the impression that dynamos were already so constructed when considered advisable, and until my question is answered must continue to think that

Unity is Strength.

Liverpool, *March 24th*, 1890.

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SLOW SPEED HIGH EFFICIENCY BEST WORKMANSHIP

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This invention is particularly applicable for Machinery in cotton, woollen, and other mills or workshops, where any class of machinery is at work, and of which the proprietor or manager requires particulars and knowledge of working, so as to know whether they are put in motion at the appointed time, and are being kept in motion and doing their proper amount of work—and this without the necessity of entering the rooms, or any part of the premises, where any of the machines and workmen are employed.

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And the performance of certain other works in connection with the said several contracts.

Tenders may be sent in for any one or more sections of the work indicated above by the letters A, B, C, D, E, F and G, or for the whole of the works, but separate prices must be stated for each section.

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Persons desiring to tender will be supplied with a copy of the specification on payment of £5 5s., which will be returned on the receipt of a tender with the specification attached, provided the Electrical Engineer shall consider such tender to be a *bonâ fide* one.

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Town Hall, Brighton, *March 6th*, 1890.

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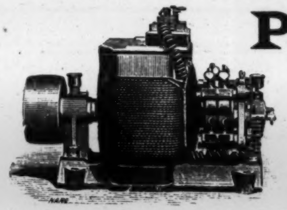

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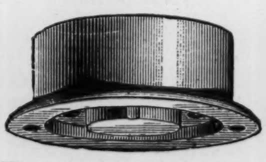

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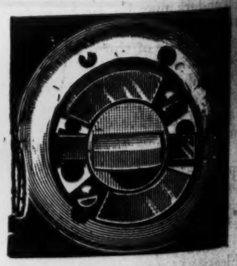

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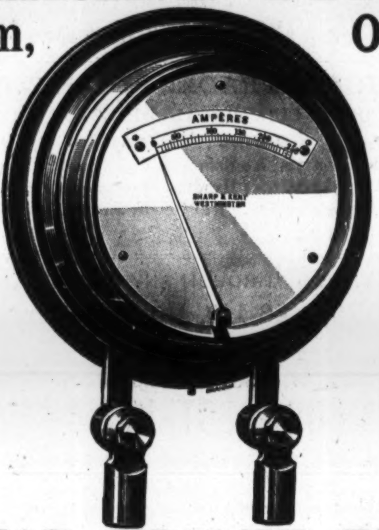

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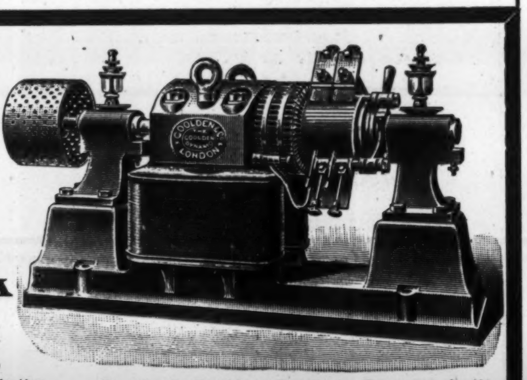

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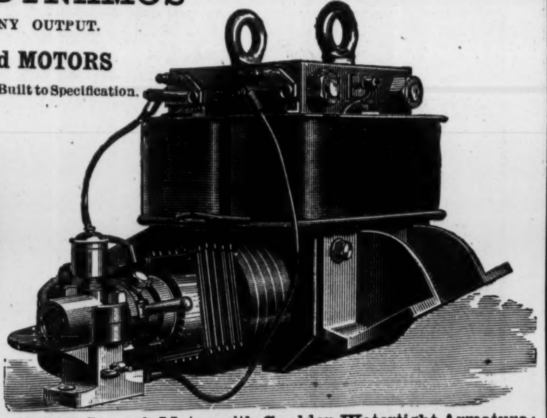

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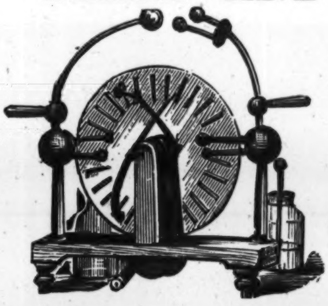

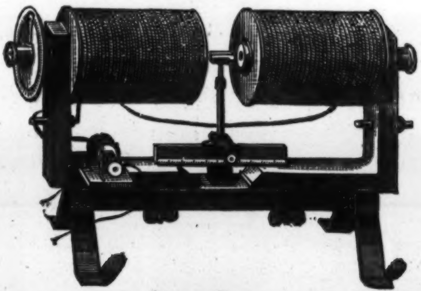

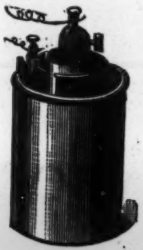

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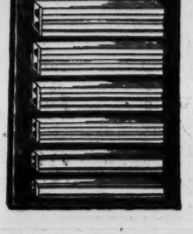

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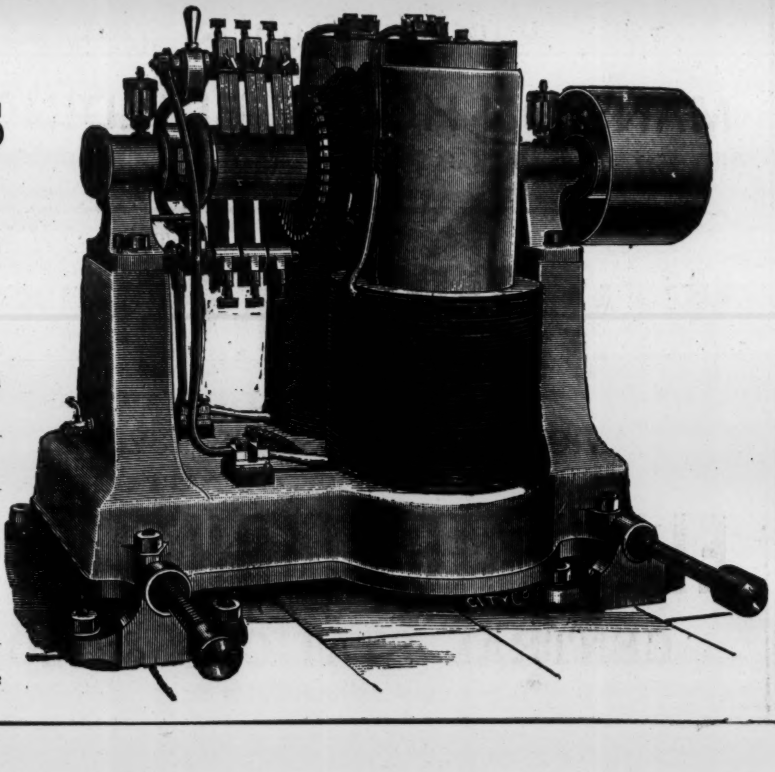

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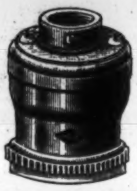

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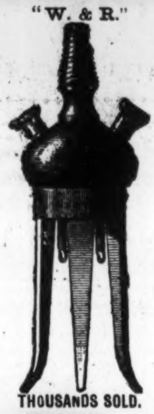

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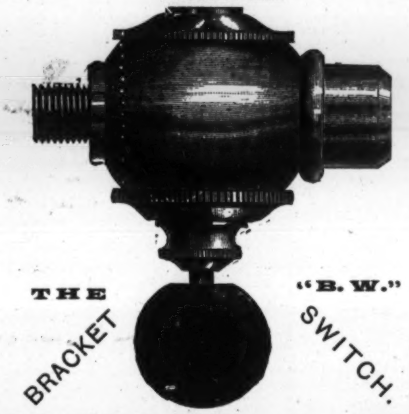

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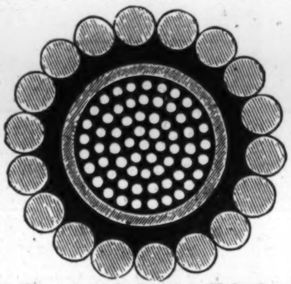

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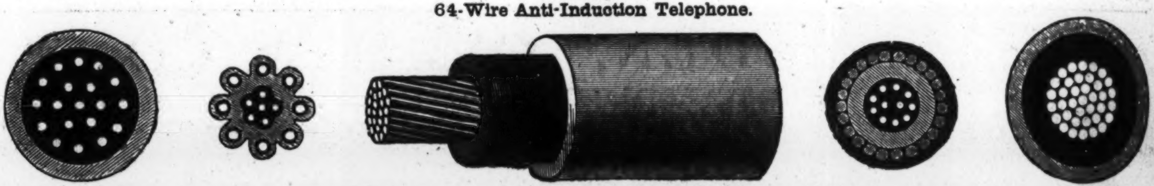

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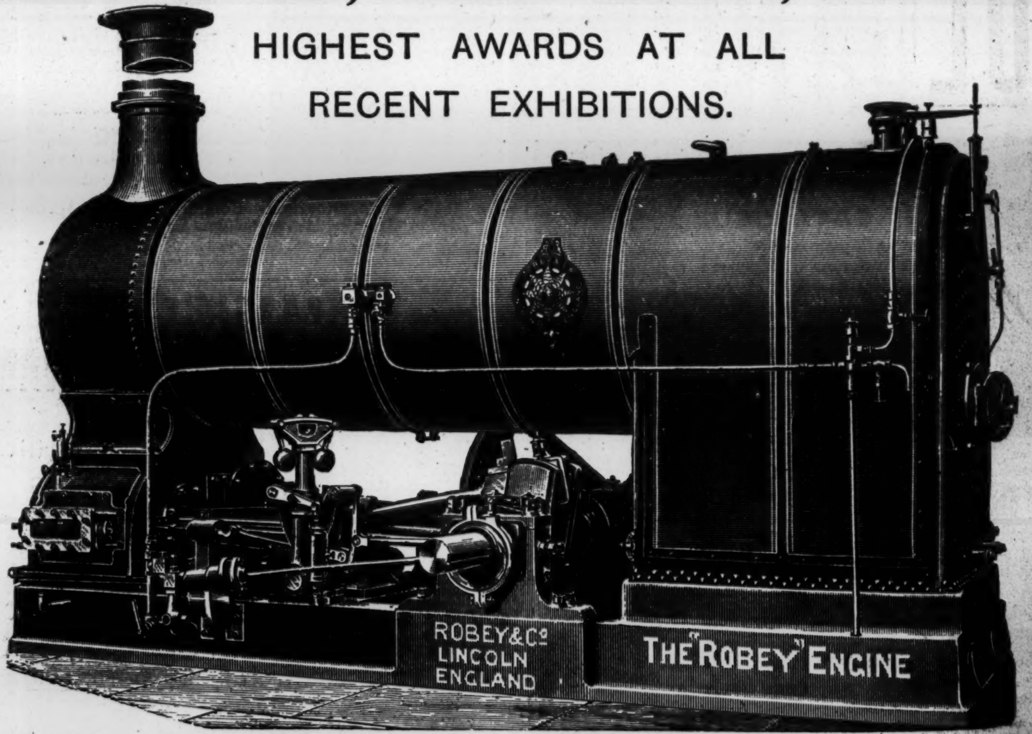

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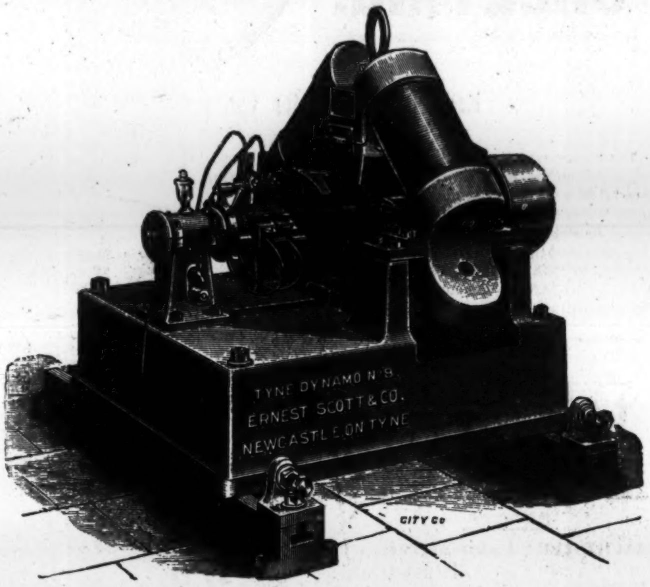
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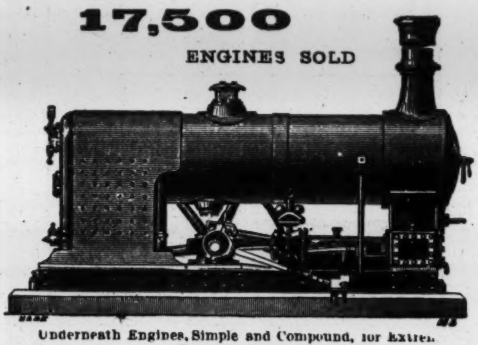
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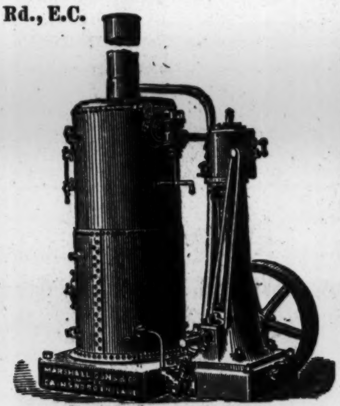
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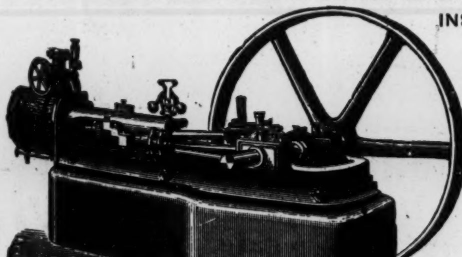
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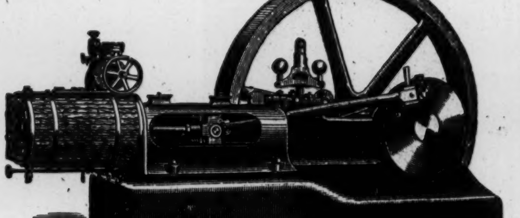
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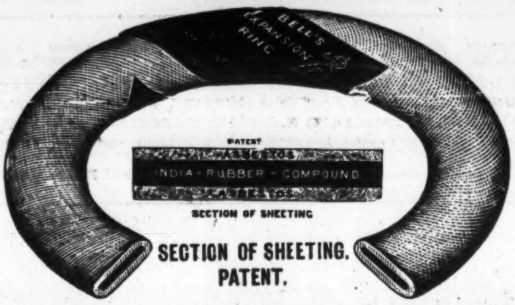

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SOUTHWARK, LONDON, S.E.

DEPOTS.
MANCHESTER: Cable Street, Blackfriars.
LIVERPOOL: 2, Strand St., James St.
HULL: Humber Dock Basin.
BELFAST, DUBLIN, ANTWERP, BERLIN,

DEPOTS:
BIRMINGHAM: 7, John Bright Street.
GLASGOW: 35, Robertson Street.
CARDIFF: West Bute Street.
BARCELONA, TRIESTE, LISBON & GENOA.

BELL'S ASBESTOS
BOILER PRESERVATIVE
Will effectually keep Boilers clean and remove any Incrustation, without injury to the Boiler Plates or Fittings.

BELL'S ASBESTOS BOILER PRESERVATIVE.
TRADE MARK
WORKS
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YARN & SOAPSTONE PACKING
Is the BEST LOCOMOTIVE PACKING made.

BELL'S
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IS SPECIALLY SUITED FOR
HYDRAULIC MACHINERY, ACCUMULATORS, AND AMMONIA AND ALL PUMPS.

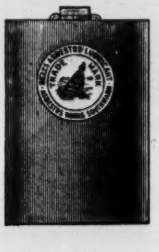
BELL'S ASBESTOS.
NON-CONDUCTING COMPOSITION.

Will reduce loss by radiation, and saves 40 per cent. of fuel.

Is sent out dry in bags therefore cheaper than others sent out wet.

All bags are marked as above.

BELL'S ASBESTOS LUBRICANT.



Any customer receiving Oil sold as Bell's Asbestos Lubricant, & Cask, Drum, or Corks not marked as

shown, is earnestly requested to forward us sample and particulars of where obtained.

ASBESTOS BELL'S LUBRICANT

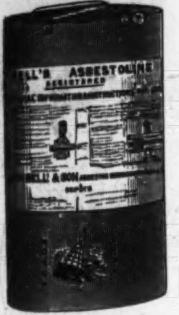
Drums are marked as above.

Every Cask is sent out as above.

All Corks are sealed as

BELL'S ASBESTOLINE.

REGISTERED.



All kegs are labelled as above.

ADVANTAGES OF ASBESTOLINE.

ASBESTOLINE is the most efficient Lubricant for all bearings.
ASBESTOLINE is the cheapest Lubricant.
ASBESTOLINE saves from 50 to 90 per cent. of the Cost of Oil.
ASBESTOLINE is the Cleanest Lubricant.
ASBESTOLINE is favoured by Insurance Companies.
ASBESTOLINE is the most Inodorous Lubricant.
ASBESTOLINE is the safest Lubricant, its flashing point being 700 F.
ASBESTOLINE has beaten all other Lubricants in making trials.
ASBESTOLINE is applicable in and out doors in every climate.
ASBESTOLINE requires no special application.

TRADE MARK.
BELL'S ASBESTOS.

CONSISTENCY OF ASBESTOLINE.

ASBESTOLINE, to meet all circumstances, is made in four degrees of consistency, A, B, C, and CC.

ASBESTOLINE A. is specially adapted to ordinary Land Engines and Machinery, in and out-door, in this country.

ASBESTOLINE B, a little more solid, is for use on Steamships in temperate climates, also on land when it is desirable to have Lubricant stiffer than A.

ASBESTOLINE C, is for use in tropical climates, both ashore and afloat. It is also invaluable in works in this country when the temperature is high.

ASBESTOLINE CC, is designed for use on calenders, paper machines, &c., where the bearings are heated by steam passing through, and sometimes is advantageously used instead of C.

The reputation of Asbestoline as a lubricant of the highest efficiency in every kind of machinery is established, and it has never been equalled by any other lubricant in the numerous cases of special difficulty in which the best oils are ineffectual. This reputation is growing daily, because it is **based on the experience of thousands of users** under the severest circumstances any lubricant has ever been subjected to, **and not on mere laboratory tests** and professional analysis of insignificant quantities. It is used with marked success in Steel and Iron Works, Collieries, Cotton and Wool Mills, and other Textile Manufactories. In Corn Mills it has proved invaluable on the roller and other modern machines. In Saw Mills, on Machines going up to 5,000 revolutions per minute, its work has never been approached by any other lubricant. On Electric Lighting Machinery, and in Steamships of all sizes throughout the world, the success of Asbestoline is unequalled. Many engines and machines of all descriptions give trouble and show bad results, both in working and wear, when the system of lubrication has not received due consideration. Engineering firms of the highest standing have given to it their powerful testimony and support.

SUPPLIED IN KEGS, 28 lbs., 56 lbs., or 112 lbs.

SPECIAL TERMS FOR LARGE QUANTITIES.

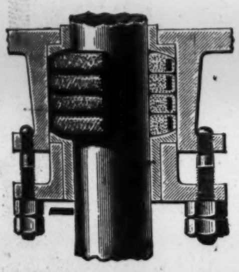
IMPORTANT TO EXPORT MERCHANTS.—One Pound of "Asbestoline" equals 2 gallons of Oil weighing 18 lbs. consequently the saving in freight is very considerable. Liberal Terms are conceded to Export Merchants.

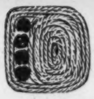
BELL'S ASBESTOS

DAGGER PACKING

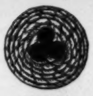
DAGGER PACKING.

Patent.





SQUARE.



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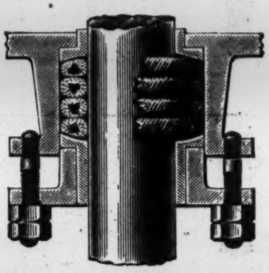

Every 10 feet has label as above, and bears our Trade Mark.

Under this registered title are included the inventions of Mr. Field, and experience has proved them to be **THE MOST EFFICIENT, DURABLE, AND ECONOMICAL PACKINGS** ever made. They constitute such a combination of Asbestos and India-rubber as secures the maximum of elasticity and heat resistance, and they are therefore **UNEQUALLED FOR EVERY KIND OF ENGINE.** These Packings are being universally used by most of the leading Steamship Companies throughout the world for ordinary Compound, Triple, and Quadruple Expansion Engines of the latest type. These Packings are composed of Rolled Asbestos Cloth, but the India-rubber is placed in two forms to suit various cases.

☞ **In ordering, state whether square or round required.** ☜

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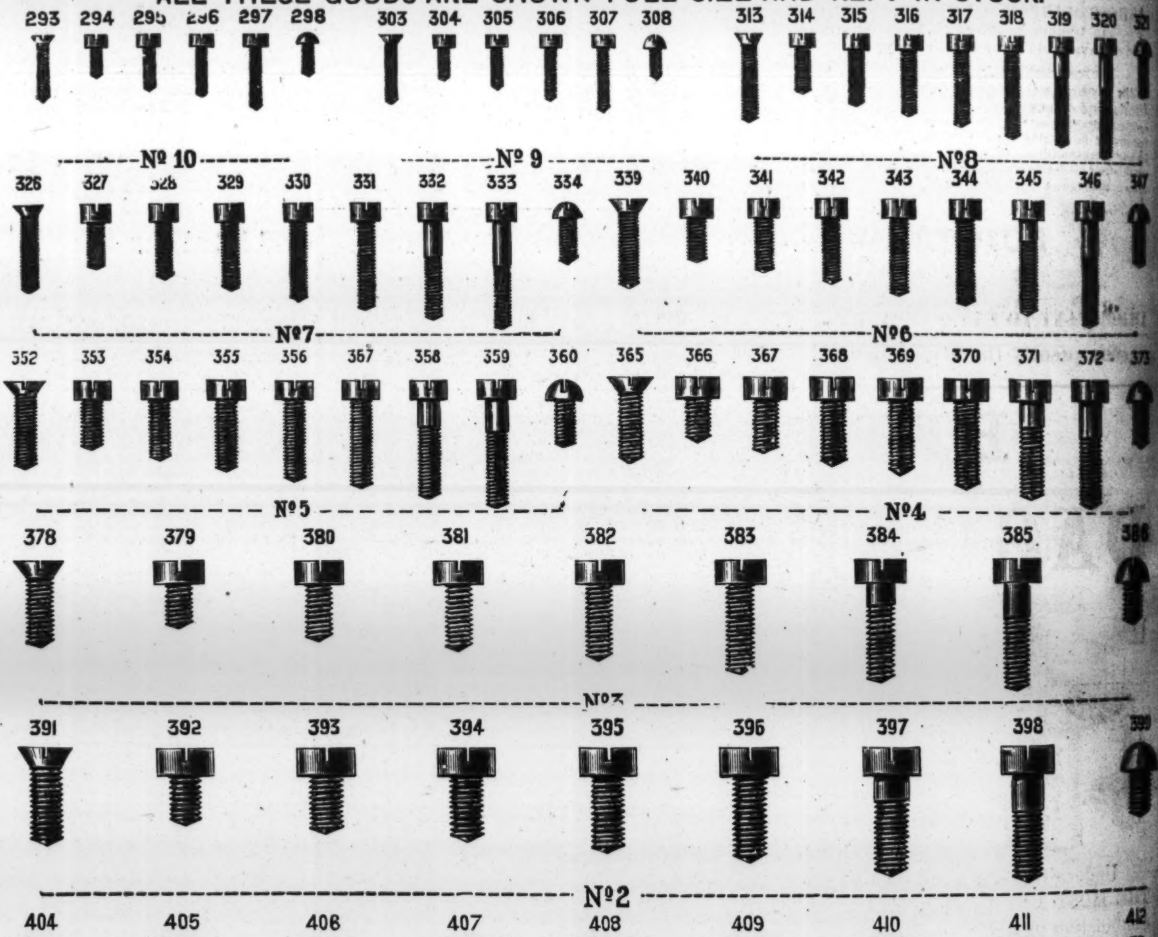

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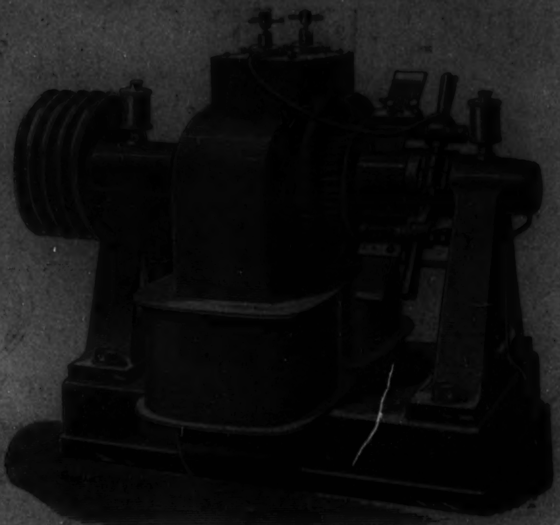

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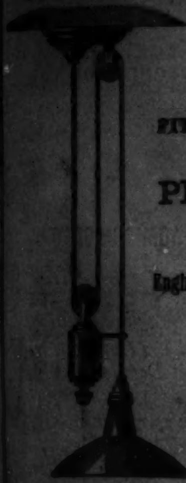

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